DOCUMENT RESUME

ED 129 985 CE 007 883

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TITLE Teaching Guide for Building Maintenance Occupations.
INSTITUTION National Evaluation Systems, Inc., Amherst, Mass.
SPONS AGENCY Illinois State Office of Education, Springfield. Div. of Adult Vocational and Technical Education.
REPORT NO VT-103-243
PUB DATE 76
CONTRACT PCB-A6-012
NOTE 138p.; For related documents see CE 007 882-886

EDRS PRICE MF-$0.83 HC-$7.35 Plus Postage.
DESCRIPTORS *Building Operation; Curriculum Development; Learning Activities; *Maintenance; *Occupational Information; *Performance Based Education; Secondary Education; Skilled Occupations; *Task Analysis; Teaching Guides; Vocational Education

ABSTRACT

This teaching guide for building maintenance is one of a series of five performance- and employer-based secondary level vocational education guides. Part 1 provides tools, resources, and a process to be used at the local level to develop a training curriculum and supporting instructional activities. It includes a comprehensive overview of the career field; a performance-based listing of maintenance job tasks and related learning objectives; a method for developing learning activity packages; two sample learning activity packages; descriptions of eight commonly used teaching methods; and a listing of instructional resources and references. Part 2 offers the guidance counselor career information and recommends steps to determine criteria for student selection and placement in the training program. It includes a theoretical framework for guidance activities in the training program; a description of the general aptitude test battery; a composite profile of the entry- level worker; a listing of instructional units of a widely used remediation program; the Worker Trait Codification System (from the "Dictionary of Occupational Titles") which provides an explanation of the knowledge, aptitude, and interest levels associated with worker trait groups; descriptions of related jobs; and job titles associated with the principal worker trait group identified for the entry-level worker. (NJ)

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ED129985

TEACHING GUIDE FOR BUILDING MAINTENANCE OCCUPATIONS

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VT-103-243

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

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Teaching Guide for Building Maintenance Occupations was produced by National Evaluation Systems, Inc., P. O. Box 226, Amherst, Massachusetts 01002, under Contract No. PCB-A6-012 with the Illinois Department of Adult, Vocational and Technical Education.

CE 007 883

ACKNOWLEDGMENTS

We wish to thank the following people and organizations for their valuable contributions to the research, conceptualization, and development of the teaching guide.

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TABLE OF CONTENTS

	Page
Preface	v
PART ONE: Guide for Curriculum and Instructional Development	
SECTION 1.1: How to Use Part One of the Guide	3
SECTION 1.2: How the Guide Was Developed	6
SECTION 1.3: General Job Description: Maintenance Worker	8
SECTION 1.4: Inventory of Job Tasks and Learning Objectives	11
SECTION 1.5: How to Develop Learning Activity Packages	30
SECTION 1.6: How to Select an Instructional Method	83
SECTION 1.7: Teaching-Learning Resources for the Instructor	94
PART TWO: Guide for Student Selection and Placement in the Training Program	
SECTION 2.1: How to Use Part Two of the Guide	103
SECTION 2.2: Career Guidance for Building Maintenance Occupations	104
SECTION 2.3: Qualifications Profile for the Entry-Level Maintenance Worker	108
SECTION 2.4: The Advanced General Education Program	113
SECTION 2.5: Worker Trait Codification System	118
SECTION 2.6: Related Jobs at Entry, Intermediate, and Advanced Levels	126
SECTION 2.7: Related Jobs by Worker Trait Group	130

PREFACE

The teaching guide for building maintenance occupations is linked to a national vocational information system which is performance-based and employer-based. It offers the instructor, guidance counselor, student, and administrator the results of an occupational analysis of the career field and presents a core of resources that can be used to develop a training curriculum at the local level. It also provides a description of the basic competencies required for advancement within the field.

The guide presents the instructor and student with statements of the actual job skills required to perform at the entry level in the building maintenance field. For the curriculum designer, the guide provides a logical system of information—job tasks, learning objectives, a suggested instructional methodology, sample learning activity packages, and teaching resources—that is adaptable to local school needs and resources. For the guidance counselor, the guide offers information and suggestions for determining the prerequisite learning needs of individual students and recommends diagnostic tools for placing students in the training program. The school administrator can use the guide as a planning and evaluative tool to strengthen existing programs or develop new ones. All users of the guide should familiarize themselves with each section so that maximum use may be made of the guide in curriculum development efforts.

The guide is divided into two parts: Part One, "Guide for Curriculum and Instructional Development" (Sections 1.1—1.7), and Part Two, "Guide for Student Selection and Placement in the Training Program" (Sections 2.1—2.7).

PART ONE: GUIDE FOR CURRICULUM AND INSTRUCTIONAL DEVELOPMENT

SECTION 1.1, "How to Use Part One of the Guide," presents a recommended, step-by-step method for using Sections 1.1—1.7. Included in the section are steps for: Background and Review, How to Plan Your Course, How to Develop Instructional Units, and Student Selection and Placement.

SECTION 1.2, "How the Guide Was Developed," explains the structure and development of the guide and the definitions of key concepts: occupational analysis, worker trait group, task statement, task inventory, and career ladder.

SECTION 1.3, "General Job Description: Maintenance Worker," provides a comprehensive overview of the career field, descriptions of the type of work performed, employment forecasts, and other important career information.

SECTION 1.4, "Inventory of Job Tasks and Learning Objectives," presents a performance-based listing of maintenance job tasks at the entry, intermediate, and advanced levels. Also included at the entry level are learning objectives related to each task. The tasks represent the significant learner outcomes of the training program; they are the core materials upon which curriculum development efforts can be based.

SECTION 1.5, "How to Develop Learning Activity Packages," explains a method for developing learning activity packages from the performance-based tasks and learning objectives. Two sample learning activity packages are presented—one based on a task and its learning objective and one on basic mathematical skills.

SECTION 1.6, "How to Select an Instructional Method," describes the uses, advantages, and disadvantages of eight of the most commonly used instructional methods and the factors involved in selecting the most appropriate method for a given learning situation.

SECTION 1.7, "Teaching-Learning Resources for the Instructor," provides the instructor with a variety of instructional resources and references for use in curriculum and instructional development efforts.

PART TWO: GUIDE FOR STUDENT SELECTION AND PLACEMENT IN THE TRAINING PROGRAM

SECTION 2.1, "How to Use Part Two of the Guide," offers the school guidance counselor a step-by-step method for using Sections 2.1–2.7.

SECTION 2.2, "Career Guidance for Building Maintenance Occupations," provides a theoretical framework for guidance activities in the training program and describes the General Aptitude Test Battery which can be used for student selection and placement.

SECTION 2.3, "Qualifications Profile for the Entry-Level Maintenance Helper," presents a composite profile of the entry-level worker and is based on worker traits associated with this career field from the Dictionary of Occupational Titles.

SECTION 2.4, "The Advanced General Education Program," lists the instructional units contained in a widely used remediation program.

SECTION 2.5, "Worker Trait Codification System," is excerpted from the Dictionary of Occupational Titles and provides an explanation of the knowledge, aptitude, and interest levels associated with worker trait groups.

SECTION 2.6, "Related Jobs at Entry, Intermediate, and Advanced Levels," is included in the guide to suggest the job and career mobility that results from training as a maintenance helper.

SECTION 2.7, "Related Jobs by Worker Trait Group," presents job titles associated with the principal worker trait group identified for the entry-level worker.

PART ONE

GUIDE FOR CURRICULUM AND INSTRUCTIONAL DEVELOPMENT

SECTION 1.1
How to Use Part One of the Guide

Part One of the guide provides tools, resources, and a step-by-step process that can be used at the local school level to develop a building maintenance occupations training curriculum and supporting instructional activities. The steps listed below present a recommended method for using the sections in Part One of the guide. The user is encouraged to follow these steps so that the best possible use of the guide can be made.

The **Background and Review** steps provide the user with a comprehensive overview of the building maintenance field and an explanation of the procedures used to develop the guide. The steps included in **How to Plan Your Course** offer a detailed procedure for using key sections of Part One to develop an up-to-date, job-related curriculum. The steps under **How to Develop Instructional Units** build on the course-planning steps and provide useful models for the development of learning activity packages which are responsive to local needs. The **Student Selection and Placement** steps offer suggestions to the instructor for coordinating course development activities with the student selection and placement activities of the school guidance counselor.

BACKGROUND AND REVIEW

STEP 1: Review how the guide was developed. Read Section 1.2, "How the Guide Was Developed," to gain a thorough understanding of the structure and development of the guide and to become familiar with these key concepts and terms: occupational analysis, worker trait group, task statement, task inventory, learning objective, and career ladder.

STEP 2: Review the information on the building maintenance field. Read Section 1.3, "General Job Description: Maintenance Worker," for an overview of the career field, descriptions of the type of work performed, employment forecasts, and other important career information.

STEP 3: Review the Inventory of Job Tasks and Learning Objectives. Study Section 1.4, "Inventory of Job Tasks and Learning Objectives," to gain another perspective on the career field. This section presents a performance-based listing of maintenance job tasks at the entry, intermediate, and advanced levels and the entry-level learning objectives. The tasks represent the significant learner outcomes of the training program; they are the core materials upon which curriculum development efforts can be based.

HOW TO PLAN YOUR COURSE

STEP 1: Examine each entry-level task and its associated learning objective. The entry-level tasks and objectives form the building blocks of a performance-based curriculum. Consider what is meant by each task and objective statement listed in Section 1.4, how it differs from other statements in the inventory, and how it relates to: the needs of your student population; the educational priorities of your school; the facilities, equipment, and instructional materials available; and the time available for instruction.

STEP 2: Rank the tasks and objectives in the order of their importance. Keeping in mind the educational priorities, needs, and resources of your school and students, rank all the entry-level tasks and objectives in the order of their importance. Your first efforts should be to divide the tasks and objectives into more manageable clusters, such as: 1 = most important, 2 = average importance, and 3 = less important. Then, rank the tasks and their objectives within each of

these clusters. The end result of this effort is a ranked list of task and learning objective statements ranging from most important to least important with regard to your educational priorities, needs, and resources. If several people are involved in course planning, their ranking of the inventory should be done independently.

STEP 3: Independently rerank the tasks and objectives. After a short period of time has elapsed (one or two weeks), all of the people who ranked tasks and objectives should repeat Steps 1 and 2. Do not refer to your initial rankings during this step.

STEP 4: Resolve any differences in the rankings. In order to improve the reliability of the rankings, resolve any differences through group discussions among the rankers and a reexamination of the tasks and their associated objectives.

STEP 5: Review your ranked entry-level list. For the finalized, ranked list of tasks and objectives, determine if you have a manageable number to teach in the time allotted for the training program. Drop the lowest-ranked statements until a manageable number is reached.

STEP 6: Sequence your entry-level task and objective list. Sequence the tasks and objectives in the approximate order in which they will be taught. (The sequence may be slightly altered when you begin developing instructional units.) There are two basic ways to sequence learning: one is based on the order in which the tasks are performed on the job, and the other is based on a building block concept. These two methods are described in more detail below. In actual practice, both sequencing methods have their place in course development. Deciding which method to use will depend on the content and performance required in a particular task or group of tasks.

- Method 1: Job Performance Order. This method provides the student with training in performing a group of tasks as they actually would be performed on the job. The sequence may be determined through employer interviews, the establishment of an occupational advisory committee, or collaboration with local training directors or supervisors.

- Method 2: Building Block Learning. The building block method means that the initial, prerequisite skills and knowledge taught serve as basic building blocks for subsequent instruction. In general, a student should progress from the simple to the complex, from the familiar to the unfamiliar, and from the concrete to the abstract. Easily learned tasks or broad concepts that have application throughout the course should be placed at the beginning of the course. Similarly, more complex tasks that depend on the mastery of several simpler tasks should be placed near the end of the course.

STEP 7: Contact maintenance personnel in your local area. In your course planning you should acquaint local maintenance personnel from industry, schools, hospitals, etc. with your course of studies, approach, and instructional activities. They may be able to provide some useful suggestions about involving students in cooperative education programs, volunteer projects, and field trip activities.

HOW TO DEVELOP INSTRUCTIONAL UNITS

STEP 1: Review the basic principles of learning: In Section 1.5, "How to Develop Learning Activity Packages," a list of basic learning principles is presented. Review the list to gain an understanding of these principles which support all types of learning activities. The principles can be applied to instructional units based on the tasks and learning objectives you selected.

STEP 2: Examine the process for developing learning activity packages. Study Section 1.5 to become familiar with the process used to

develop learning activity packages which utilize the performance-based tasks and learning objectives. Section 1.5 provides two sample learning activity packages—one based on a task and its associated learning objective and one based on the skills of approximation and estimation.

STEP 3: Develop your own learning activity packages. Design your own packages based on the process described in Section 1.5. Blank worksheets are provided at the end of Section 1.5 for this purpose.

STEP 4: Select methods of instruction and supporting activities. Use the following sections of the guide to support each learning activity package: Section 1.6, "How to Select an Instructional Method," and Section 1.7, "Teaching-Learning Resources for the Instructor."

STUDENT SELECTION AND PLACEMENT

STEP 1: Review the guidance sections in Part Two of the guide. Review the sections in Part Two of the guide to gain an understanding of how the guidance activities relate to and support your curriculum and instructional development activities. It is especially important to review Section 2.3, "Qualifications Profile for the Entry-Level Maintenance Worker."

STEP 2: Coordinate your efforts with the school guidance counselor. Discuss student selection and placement activities with the school guidance counselor in order to establish criteria for selection and placement of students in the training program.

SECTION 1.2
How the Guide Was Developed

The teaching guide for building maintenance occupations represents a significant step in the development of training programs that are closely linked with employer requirements and employment opportunities. It is based on the premise that students should be trained in the actual job skills identified by maintenance personnel and institutions for entry-level positions. Its aim is to put into the hands of educators at the local level a core of materials that can be used to develop a training program based on their needs and resources. This section of the guide describes the procedures used to develop the teaching guide and provides the background information needed for effective use of each section.

Development of the teaching guide began with the identification of a family of jobs within the field which were related through their required levels of performance and knowledge. Extensive use was made of the Dictionary of Occupational Titles (D.O.T.),* U.S. Civil Service Commission documents, and related supplements in identifying job families.

The criteria used for selecting jobs that would, in effect, define the field included:

Broad Entry-Level Tasks. Jobs were selected which required the performance of a broad range of entry-level skills and knowledge when compared to related jobs.

Job Mobility. Jobs were selected that entailed skills and knowledge which could be applied to jobs higher on a career ladder concept beginning at the semi-skilled or entry level and proceeding upward, job by job, to the advanced level. Jobs that did not provide an opportunity for upward mobility within the career field were screened out.

Career Flexibility. Job skills and knowledge which could be applied to jobs outside the field were selected. This criterion reflected concern for students who might partially or entirely finish the training program and then decide to enter another career field.

Future Employment Opportunities. Available employment forecasts were used to select jobs for inclusion in the job family for which there was an anticipated need nationwide.

Training Time Requirements. Jobs were selected for which entry-level training could be completed within a two-year program.

Training Flexibility. Jobs were screened in terms of their projected training cost, support requirements, and facilities required.

After this composite picture of the building maintenance field had been produced by defining a representative family of jobs, title jobs were selected to represent the job family at the entry, intermediate, and advanced levels of performance. Encompassing the broadest range of skills and knowledge within the job family, the title jobs chosen were: maintenance helper (entry level), maintenance worker (intermediate level), and maintenance supervisor (advanced level).

The next step involved generating a list of tasks and associated learning objectives to represent the basic skills and knowledge required at the entry level. This step was based on a careful analysis of the D.O.T., U.S. Civil Service Commission job grading standards, employer interviews, and an evaluation of existing inventories of maintenance tasks and learning objectives.

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* U.S. Department of Labor. Dictionary of Occupational Titles (Vol. 1, Definition of Titles; Vol. 2, Occupational Classification) (3rd ed.). Washington, D.C.: U.S. Government Printing Office, 1965.

The inventories appearing in this guide are the result of this analysis and evaluation. In support of the entry-level inventories, task statements were compiled and evaluated at the intermediate and advanced levels. The higher-level task inventories indicate the competencies and knowledge required as the worker progresses up the career ladder. All three task inventories (entry, intermediate, and advanced) are conceived as a core of job performance skills which can be adapted to local educational needs and available school resources.

The final task and learning objective inventory at the entry level (and the intermediate and advanced task inventories) in Section 1.4 are the bases from which the other sections of the guide were developed: the general job description, the recommended methodology for creating learning activity packages, and the strategies and diagnostic tools available for placing students in the training program.

The methodology used in developing the teaching guide has several important implications for curriculum development efforts. First is the close link established between curriculum intent and instructional practice. If the recommended procedures for developing learning activity packages are followed, relevance of the instructional content is guaranteed since the occupational analysis produced only the essential, as opposed to the "nice-to-know," tasks and objectives required for acceptable job performance. No matter which tasks and objectives the instructor selects from the inventories, the resulting curriculum content relates to the capabilities derived from the occupational analysis.

Second, since the analysis produced many more tasks than a two-year curriculum could logically utilize, the final set of instructional units is determined at the local level by the instructor, who is in the best position to make such decisions. The instructor's selection of tasks and objectives from the entry-level inventory is made on the basis of identified local employment opportunities, students' needs, and resources available. Consequently, the teaching guide represents a flexible set of materials that can be revised and updated in response to the changing requirements of the career field.

SECTION 1.3
General Job Description: Maintenance Worker

The General Job Description provides instructors, career guidance counselors and students with an introduction to the career field of maintenance. The information contained in this section* includes an overview of the career field, specific descriptions of the type of work done by the maintenance worker, places of employment, training requirements, employment forecasts, expected earnings, working conditions, and sources of additional career information.

NATURE OF THE WORK

The need for maintenance workers coincides with the continued growth of urban and suburban centers. As more factories, plants, hospitals, office buildings, and other commercial structures are built, large numbers of people are needed to clean and maintain them.

Maintenance workers see that heating and ventilating equipment work properly, keep the building clean and orderly, and do other tasks that keep a building in good condition. On a typical day, a maintenance worker may wet- or dry-mop floors, vacuum carpets, clean equipment, make minor repairs, and exterminate insects and rodents.

Maintenance workers use many different tools and cleaning materials. For one job, they may need only a simple mop; for another, they may use an electric polishing machine and a special cleaning compound. Chemical cleaners and power equipment have reduced the effort needed for cleaning jobs. Maintenance workers must be familiar with cleaning equipment and materials designed for specific tasks because improper use of a chemical cleaner or machine may harm surfaces.

Some maintenance workers supervise the cleaning and maintenance of an entire building or section of a building, and see that jobs, such as floor waxing or furniture polishing, are done well.

PLACES OF EMPLOYMENT

In 1972, about 1.9 million people—75 percent of them men—worked as building maintenance workers. Although jobs for maintenance workers are found in cities and towns throughout the nation, the majority work in the more populated areas of the country.

Many maintenance workers are employed by factories, as well as hospitals, hotels, and retail stores. Large numbers also work in apartment houses and office buildings; some are employed by contract firms that provide building maintenance service for a fee.

TRAINING, OTHER QUALIFICATIONS, AND ADVANCEMENT

No special education is required for most maintenance jobs, but students looking for advancement within the field should participate in a training program which provides experience in basic maintenance skills. Most maintenance workers learn their skills on the job. Usually, beginners do routine cleaning. As workers gain experience, they are given more complicated duties and responsibilities.

In some cities, unions and government agencies have programs to teach necessary maintenance

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*This section has been excerpted from the Occupational Outlook Handbook (1974-75 Edition), U.S. Department of Labor, Bureau of Labor Statistics, Bulletin 1785, and from "Job Grading Standard for Maintenance Mechanic (WG-4749)," U.S. Civil Service Commission, Bureau of Policies and Standards, TS-30, 1974.

skills. Students learn about the different kinds of surfaces in modern buildings and ways to clean them. They learn to operate and maintain machines, such as wet and dry vacuums, buffers, and polishers. They also receive instructions concerning minor electrical, plumbing, and other repairs. Students learn to plan their work, to deal with the public, and to work independently without supervision. A few training programs offer remedial courses in reading, writing, and arithmetic.

Advancement opportunities for maintenance workers may be limited in a small factory or commercial building. Where there is a large maintenance staff, however, workers can be promoted to supervisory jobs. For advancement to supervisor, a high school diploma is helpful. Some maintenance workers become self-employed and maintain buildings for clients on a fee basis, after becoming thoroughly familiar with the work.

Maintenance workers usually find work by answering newspaper advertisements or by applying directly to a company. They also get jobs through state employment offices. For government positions, an employment application must be filled out and the civil service personnel headquarters contacted.

EMPLOYMENT OUTLOOK

Employment of maintenance workers is expected to rise moderately through the mid-1980's as the construction of new factories and other buildings that use maintenance workers expands.

In addition to the large number of new jobs that will be created, thousands of workers will be needed each year to replace experienced maintenance workers who retire, die, or leave for other reasons.

EARNINGS AND WORKING CONDITIONS

Earnings of maintenance workers vary by industry and area of the country; workers in large cities of the North Central region earn the highest wages. In 1971-72, maintenance workers in private industry had the following average hourly earnings, according to a Bureau of Labor Statistics survey in urban areas:

Industry	Average hourly earnings
Manufacturing	$3.23
Public Utilities	3.33
Wholesale Trade	2.80
Retail Trade	2.37
Finance	2.68
Services	2.32

In general, maintenance workers earn about three-fourths as much as the average earnings for all nonsupervisory workers in private industry, except farming.

In the federal government, maintenance workers' pay rates are similar to those paid by private industries in the same local areas.

Most maintenance and other building service workers receive paid holidays and vacations, and health insurance.

Although maintenance workers usually work inside heated, well-lighted buildings, sometimes they work outdoors sweeping walkways, mowing lawns, or shoveling snow. Those who maintain machinery and heating systems may work in noise and grease.

Workers often suffer from minor cuts, bruises, and burns caused by machines, hand tools, and chemicals. An additional hazard of maintenance work is heavy lifting.

Maintenance workers stand up most of the time at work. Many tasks, such as dusting or sweeping, require constant bending, stooping, and stretching. Some must clean buildings after the regular staff has left for the day. To provide 24-hour maintenance, workers may be assigned shift work.

SOURCES OF ADDITIONAL INFORMATION

Information about opportunities in maintenance work and training under provisions of the Manpower Development and Training Act and other legislation may be obtained from the local office of the Illinois Employment Service.

General information on job opportunities and wage rates in local areas may be obtained for this occupation from: Service Employees International Union, 900 17th St. NW, Washington, D.C. 20006.

A variety of federal agencies have assigned job designation codes to the position of maintenance worker. These codes are commonly used by federal, state, and local governments. When requesting career information, use these code numbers:

U.S. Civil Service Designation: WG-4749

U.S. Department of Labor (D.O.T.) Designation: 187.168, 381.137 and .887, 382.884, and 891.138

Standard Industrial Classification Manual Designation: 7349

Office of Education Code: 17.1000, 17.1100

SECTION 1.4
Inventory of Job Tasks and Learning Objectives

This section of the guide presents the job task and learning objective inventories for maintenance work at the entry level and task inventories at the intermediate and advanced levels. The tasks and their associated learning objectives at the entry level represent the significant learner outcomes of the training program and thus are the core materials upon which curriculum and instructional development efforts can be based. The task inventories at the intermediate and advanced levels suggest the career mobility within the field of maintenance and the corresponding increase of difficulty and responsibility involved as one progresses up the career ladder.

Preceding each inventory is a brief overview of the title job for the entry level, intermediate level, and advanced level. The letter and number codes preceding each job task statement and its associated learning objective are for identification purposes only. They should not be interpreted as sequential steps or rankings of the tasks by importance. Abbreviations used are: E = entry-level tasks, I = intermediate-level tasks, A = advanced-level tasks.

Section 2.3 provides a qualifications profile of the knowledge, aptitudes, interests, and temperaments required to perform these tasks successfully at the entry level. Sections 2.3 and 2.5 of this guide and the Dictionary of Occupational Titles provide additional information about and detailed explanations of these worker traits.*

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* Worker traits are the abilities, personal traits, and individual characteristics necessary for a worker to achieve average successful job performance.

ENTRY-LEVEL JOB TITLE: MAINTENANCE HELPER

At the entry level the worker performs a variety of duties involving the upkeep of buildings, grounds, and related structures, fixtures and utilities of the physical plant to assist maintenance workers, mechanics, and other workers in completing their tasks. The maintenance helper assists workers and performs routine tasks as directed by his or her immediate supervisor. The helper makes simple repairs under direct supervision; uses, cleans, lubricates, and stores maintenance tools and equipment; and, with experience, performs progressively more complex tasks. The maintenance helper may be rotated from job to job wherever needed, assigned to a specific activity, or may be working toward a formal apprenticeship in one of the building trades. Assignments may include the performance of visual examinations and operational tests to determine the need for, and the performance of, maintenance and minor repair work, although at the entry level these assignments are usually under the direct supervision of a more experienced worker. After basic skills have been learned, the maintenance helper works from oral instructions, maintenance program plans, technical manuals, specifications and similar guides.

ENTRY-LEVEL TASKS AND OBJECTIVES

	Task	Objective
E-1	Remove dirt and grease from resilient or hard floors by wet mopping.	Given a mop and handle, bucket and wringer, water and a neutral soap, the student will be able to remove dirt and grease from resilient or hard floors so that the floor contains no visible dirt or grease.
E-2	Disinfect a rest room floor by wet mopping.	Given a rest room, mop and handle, bucket and wringer, and a germicidal disinfectant, the student will be able to disinfect a rest room floor area by wet mopping according to instructor-provided instructions.
E-3	Wax a floor.	Given a mop bucket, wringer, clean mop and handle, and floor finish wax, the student will be able to wax a floor so that the floor has an even coat of finish containing no streaks or bubbles.
E-4	Spray buff a floor.	Given a floor machine, spray attachment, spray bottle, buffing pad, floor finish, and a steel wool kick pad, the student will be able to spray buff a floor so that high-traffic areas are buffed to their original gloss and scuff marks and black marks are removed.
E-5	Seal a resilient floor.	Given a mop bucket, wringer, clean mop and handle, and floor seal, the student will be able to seal a resilient floor so that the floor has an even coat of seal applied to it and so that it contains no streaks or bubbles.
E-6	Seal a new wood floor.	Given an applicator pan, lambs-wool applicator, push broom, vacuum cleaner, clean (untreated) dust mop, floor seal, solvent, and No. 2 steel wool pads, the student will be able to seal a new wood floor so that the wood floor has an even coat of seal applied to it and so that it contains no streaks or bubbles.
E-7	Remove solutions from floors.	Given a wet vacuum and a floor tool attachment, the student will be able to remove solutions from floors so that no signs of solutions remain on the floor.

	Task	Objective
E-8	Strip or light scrub a floor using an automatic floor machine.	Given an automatic floor machine, buckets and wringers, mops, wax remover, scrub soap, steel wool kick pad and stripping pads, the student will be able to strip or light scrub a floor using the automatic floor machine so that all old wax and black marks are removed from the floor.
E-9	Operate a floor machine.	Given a floor machine and the appropriate brush and pad, the student will be able to operate a floor machine so that the floors are buffed according to manufacturer instructions.
E-10	Sweep and mop stairs.	Given a push broom, mop and handle, bucket and wringer, dust pan, bench brush and a wiping cloth, the student will be able to sweep and mop stairs so that the stairways do not contain any visible dirt, debris or stains.
E-11	Clean, seal, wax and buff a resilient floor.	Given three mops, three pails, two wringers, stripping solution, sealer, wax, wet vacuum, floor machine, wire brush, scrubbing pad and a buffer pad, the student will be able to clean, seal, wax and buff a resilient floor so that the floor is free of all visible dirt.
E-12	Care for hard-surfaced floors.	Given a dust mop, broom, bench brush, dust pan, mop, two mop pails, one mop wringer, floor machine, and a wax spray bottle, the student will be able to give hard-surfaced floors the proper daily care needed for one week so that the floors are free of visible dirt and trash.
E-13	Treat a dust mop.	Given a new mop head, mop oil, and a hand sprayer, the student will treat a dust mop evenly, hang it up in the proper manner, and not use it for 12 hours after treating.
E-14	Perform a job according to verbal or written instructions.	Given a specific job and verbal or written instructions, the student will be able to perform the job according to the given instructions.

	Task	Objective
E-15	Replace burned-out or faulty fluorescent lamps.	Given a new fluorescent lamp and a step ladder or scaffold, the student will be able to replace burned-out or faulty fluorescent lamps so that all fluorescent lamps have no darkened ends and operate properly.
E-16	Wash fluorescent fixture.	Given a step ladder, two 12-quart pails, sponge, wiping cloths and all-purpose cleaner, the student will be able to clean fluorescent lamp fixtures so that the lamp fixtures do not contain any dust or dirt.
E-17	Wash and spot-clean walls.	Given a spray bottle, sponge, wiping cloths, all-purpose cleaner, and a 12-quart pail, the student will be able to wash and spot-clean walls so that all visible dirt and smudges are removed from the wall.
E-18	Wash or spot-clean windows.	Given a 12-quart pail, window squeegee, several wiping cloths or a chamois, glass cleaner, and a spray bottle, the student will be able to wash or spot-clean windows so that dirt, smudges, and streaks are removed from the windows.
E-19	Clean and maintain equipment.	Given wiping cloths and all-purpose cleaner, the student will be able to clean and maintain equipment so that the equipment does not have any visible dirt on it and so that it is properly maintained according to manufacturer instructions.
E-20	Clean and polish metal surfaces.	Given a metal surface, metal polish, wiping cloths, and a sponge, the student will be able to clean and polish metal surfaces so that the metal surfaces (chrome, aluminum, or stainless steel) do not have any rust, smudges, or stains on them.
E-21	Secure building and property.	Given a school building, hospital building, or industrial plant, the student will be able to secure the buildings so that no person can enter the buildings or property without damage or tripping alarms.

Task		Objective
E-22	Replace broken window glass.	Given a broken window glass, replacement glass, putty, putty knife, pliers, hammer, container for broken glass, and a tape measure, the student will be able to replace the window so that the glazing compound is smooth, even, and tight against the sash all the way around, and the glass is secure and clean of all dirt and smudges.
E-23	Repair damaged wall.	Given a damaged wall, plaster, dry wall, tape, hammer, nails, and a plaster spatula, the student will be able to repair a damaged wall so that by rubbing one's fingers over the patched area no high or low spots can be felt and no scratches on the paper section of the wall board can be seen.
E-24	Paint wall.	Given a wall that needs to be painted, primer paint, finish paint, wire bowl, paint brush, roller, roller paint pan, thinner and other chemicals that might be needed, such as: degreasers, acids, etc., the student will be able to paint a wall so that it is not streaked, all of the wall is covered, and there is no paint on areas other than the wall being painted.
E-25	Paint an interior wall.	Given paint, brush, scraper, sandpaper, primer, putty, and a putty knife, the student will be able to paint a wall so that the wall is smooth and free of all marks and has an even coat of paint over an entire area.
E-26	Paint an exterior wood wall.	Given a scraper, wire brush, sandpaper, paint brush, primer putty, putty knife, paint, turpentine, and rags, the student will be able to paint an exterior wall so that the surface is smooth and clean and no holes, knots or brush marks are visible.
E-27	Repair dripping faucets.	Given a screwdriver, adjustable wrench, pliers, seat dressing tool, and a dripping faucet, the student will be able to replace the rubber gasket on a faucet so that the drip is stopped.

	Task	Objective
E-28	Clear clogged drains and traps.	Given a clogged drain or trap, rubber plunger, overflow drop cloth, liquid drain cleaner, drip pan, pipe wrench, and a plumber's snake, the student will be able to clear the drain or trap so that no impediments to drainage can be observed.
E-29	Clean and polish aluminum surfaces.	Given an aluminum surface, pail, sponge, and cleaners, the student will be able to clean and buff the aluminum surface so that when finished the aluminum is free of all visible dirt and stains.
E-30	Use a tube cutter to cut off a piece of copper tubing.	Given a piece of two-inch copper tubing, tube cutter and 12-inch tape, the student will be able to cut off a piece of tubing so that the cut is one inch in length, has a smooth, straight cut, and no burrs or rough edges are left on the tube edge.
E-31	Use a flaring tool to make a flare on the end of a copper tube.	Given a piece of soft copper (either 1/4", 3/8", or 1/2") and a flaring tool, the student will be able to make a flare on the end of a tube so that the flare has a smooth, straight, 45-degree lip all the way around without breaks or cracks.
E-32	Make a sweated joint on a copper tube.	Given sandpaper, emery cloth, soldering flux, solder brush (stiff), roll solder, copper tubing, fittings, propane torch, and a tubing cutter, the student will be able to make a sweated joint so that a leak-proof and strong joint without breaks or cracks is obtained.
E-33	Sweat-fit a copper "T" into an existing line.	Given the job of adding an additional outlet "T" to an existing water line and the needed equipment, the student will be able to measure, layout, and sweat the line and fittings together so that an even supply of solder appears all around the connection, and no leaks occur when pressure is applied.

	Task	Objective
E-34	Operate a propane torch.	Given a propane torch and spark igniter, the student will be able to light and adjust the flame so that the torch ignites as soon as a spark is supplied and burns with a blue flame from 1 to 1½ inches in length.
E-35	Cut, taper, and thread a length of pipe using a power threading machine.	Given a power threading machine and predetermined tolerances for cutting, tapering, and threading, the student will be able to cut, taper, and thread a length of pipe within the tolerances.
E-36	Use a power-driven cutting tool to cut off three pieces of pipe to a length of four inches, six inches, and eight inches.	Given a power-driven cutting tool and a length of galvanized pipe, the student will be able to cut off three pieces of pipe to a length within 1/16" of four inches, six inches, and eight inches.
E-37	Check and service an air compressor according to schedule.	Given an air compressor in need of servicing, a small tool kit, a solvent cleaner, wiping cloths, and No. 000 sandpaper, the student will be able to check and service it according to schedule so that it produces the necessary air pressure without running constantly.
E-38	Taper interior ends of a galvanized pipe using a power-driven pipe machine.	Given a length of pipe and power-driven pipe machine, the student will be able to taper the ends so that the inside of the pipe is smooth and the pipe thickness remains the same.
E-39	Cut the proper threads on ends of galvanized pipe using a power threading machine and tapering pin.	Given galvanized pipe, power threading machine, and a tapering pin, the student will be able to cut the proper threads on ends of galvanized pipe so that the threads are clean and sharply cut, are three-fourths of an inch in length, and can be threaded onto a fitting.
E-40	Install chain link fence.	Given an area to be fenced in, the student will be able to install a chain link fence so that the posts are in a straight line, level and an equal distance apart; and the fence is stretched tight and thoroughly fastened at the top, middle and bottom of the posts.

	Task	Objective
E-41	Determine water level in a boiler.	Given a boiler, the student will be able to determine water level by reading water level in a glass gauge and by testing water level by opening pet cocks with 100% accuracy.
E-42	Label shelves for storage of material in a storeroom.	Given labeling material, a pencil, and labeling instructions, the student will be able to correctly label storeroom shelves for the storage of material.
E-43	Break in a new chalkboard.	Given several sticks of white chalk, felt eraser, and a soft chamois or soft cotton cloth, the student will be able to break in a new chalkboard so that the new blackboard, when written upon, can be erased leaving no signs of writing.
E-44	Wash a blackboard.	Given a 12-quart pail, sponge, and a felt eraser, the student will be able to wash a blackboard so that all chalk is removed from the surface, leaving no streaks.
E-45	Shampoo a carpet using the dry-foam method.	Given a self-propelled dry-foam shampoo machine, shampoo, 12-quart pail, short-bristled brush, upright vacuum cleaner, and a carpet brush, the student will be able to shampoo a carpet using the dry-foam method so that all visible embedded dirt is loosened from the carpet and the pile is lifted.
E-46	Shampoo a carpet with a rotary machine.	Given a rotary carpet shampooer, wet vacuum pick-up, upright vacuum cleaner, shampoo, carpet spotter, carpet tool for wet vacuum, and several 2"x2" cardboard or plastic squares, the student will be able to shampoo a carpet with a rotary machine so that all embedded dirt is removed from the carpet and the fibers are lifted.
E-47	Vacuum a carpet.	Given an upright vacuum sweeper, the student will be able to vacuum a carpet so that the carpet does not contain any visible dirt or debris.

	Task	Objective
E-48	Remove stains and gum from carpets.	Given a carpet with a stain or gum spot, stain remover, soft cotton cloth, and gum remover, the student will be able to remove stains and gum from carpets so that all stains and/or gum spots are removed from the carpet, leaving no visible residue.
E-49	Spot-clean or clean an entire carpet area.	Given a vacuum cleaner, hand-trigger sprayer, 2½-gallon pressure sprayer, rotary floor machine, special drive block, pad, mop, pail, water wringer and carpet sheen, the student will be able to spot-clean an entire carpet area so that no soiled spots are visible.
E-50	Take care of any carpeted area for daily cleaning, spotting, and shampooing for one week.	Given a vacuum cleaner, spot cleaner, hand mop cleaner, shampoo machine, sprayer, floor machine, mop head, mop head attachment, pressure sprayer, mop pail and a mop wringer, the student will be able to take care of any carpeted area for daily cleaning, spotting, and shampooing for one week so that the carpet has no soil spots or trash visible.
E-51	Dust any given surface.	Given an office, wiping cloths, hand duster, and glass cleaner, the student will be able to dust any given surface so that any given surface does not contain any dust.
E-52	Clean a desk top.	Given an office, wiping cloths, glass cleaner, furniture polish, and a spray bottle, the student will be able to clean a desk top so that the desk top does not have any fingerprints, dust, or streaks on the surface.
E-53	Clean offices.	Given a vacuum cleaner, dusting brush, dust cloth, and furniture polish, the student will be able to clean offices so that the floors are free of all soil and stain spots, the desk tops, cabinets and ledges are free of dust, and the walls are free of all visible soil.

	Task	Objective
E-54	Remove snow and ice.	Given sidewalks covered with snow and ice, a snow shovel, power snow removal equipment, rubber boots or overshoes, gloves, sand and/or chemical compound, an ice scraper and buckets, the student will be able to remove snow and ice so that all snow and ice are removed and where ice still exists, sand and/or chemical compound has been spread on it.
E-55	Prune shrubbery.	Given shrubbery, pruning shears, sharp knife, and a saw, the student will be able to prune shrubbery to a predetermined uniform shape.
E-56	Identify all control devices, their locations, and the safety rules related to the operation of a tractor.	Given a tractor, the student will be able to identify all control devices, their locations, and the safety rules involved, according to recommended manufacturer standards.
E-57	Operate the tractor.	Given a tractor, the student will be able to operate the tractor according to given safety procedures so that the tractor moves forward and backward without stalling, and without jerking starts and stops.
E-58	Operate a forklift truck backward and forward, and left and right.	Given a forklift truck, the student will be able to operate the truck backward and forward, and left and right, so that the tractor moves without stalling and without jerking starts and stops.
E-59	Load and unload material with a forklift truck.	Given a forklift truck, the student will be able to load and unload material so that the load is centered on the forks and is slightly tipped to the rear, piled straight, and does not fall down.
E-60	Identify samples of material and tools and written information by name.	Given samples of material and tools and written information, the student will be able to identify each sample by name, what it is used for, when it is used, and how it is used.
E-61	Mix and pour a cement form.	Given wood forms, reinforcing rod, cement mixer, cement, gravel, shovel, and water, the student will be able to mix and pour a form so that the cement is smooth and hard and metal rods are in the center of the form.

	Task	Objective
E-62	Mix cement.	Given a cement mixer, cement, aggregate, water, shovel, and a pail, the student will be able to correctly mix cement according to manufacturer specifications.
E-63	Mow a lawn using a power-operated hand mower.	Given a lawn area and a power-driven hand mower, the student will be able to mow a lawn so that the area is neatly cut in straight lines and no clippings are left on cement areas.
E-64	Operate a small lawn tractor with mower attachment.	Given a small lawn tractor with mower attachment, the student will be able to operate and mow grass with this equipment in a smooth and safe manner; cut the grass to a height of two inches without leaving any long grass standing; and make cuts as straight as possible except where trees and sidewalks make it impossible.
E-65	Water a lawn.	Given a lawn area, garden hose, sprinkler, pan, and a water source outlet, the student will be able to water the lawn area according to predetermined instructions.
E-66	Operate and maintain a mechanical spreader.	Given a mechanical spreader, the student will be able to explain out loud the operation of it; adjust the setting as required; push it at the proper speed; and perform the proper maintenance according to manufacturer specifications.
E-67	Spread fertilizer on a lawn.	Given an existing lawn, fertilizer, and a spreader, the student will be able to spread the fertilizer on the lawn so that all directions on the container are followed and the correct amount is completely and evenly applied to the entire area.
E-68	Prepare soil for new lawn.	Given a small area of land, the student will be able to prepare the soil for a lawn so that the area conforms to a predetermined slope, has no low spots or stones, and has a predetermined amount of top soil and fertilizer for good growth.

	Task	Objective
E-69	Plant a new lawn.	Given a small area of land ready for planting, the student will be able to plant a new lawn so that the seed and straw are spread evenly over the entire area and the ground is kept damp until the grass is three inches high.
E-70	Run a lawn edger.	Given a lawn edger, coarse bristle push broom, flat shovel, and a waste container, the student will be able to operate a lawn edger so that the grass and soil are cut in a line along the edge of the concrete three inches deep.
E-71	Collect paper and trash.	Given a building with paper and trash, four-wheel push truck, dust pan, dust pan broom, gloves, container for non-combustible material, wiping cloths, twine and detergent, the student will be able to collect paper and trash so that no signs of paper and trash exist around the building.
E-72	Make paper and trash ready for disposal and return the equipment involved.	Given paper and trash that have been collected, equipment, and materials for collection, the student will be able to make the paper and trash ready for disposal and return the equipment so that the paper and trash meet performance inspection standards and the equipment is clean and returned to the assigned storage area.
E-73	Pick up and dispose of trash.	Given a four-wheel cart, two trash containers, plastic liners, central trash area, bench brush, and a dust pan, the student will be able to pick up and dispose of trash so that all waste paper containers and garbage cans are emptied, plastic liners are replaced, and waste is deposited in the main containers at the central trash area.
E-74	Fill rest room dispensers.	Given toilet paper, hand towels, liquid or bar soap, sanitary napkins, and keys to dispensers, the student will be able to fill all rest room dispensers so that all rest room dispensers are supplied for the following day.

	Task	Objective
E-75	Clean sinks and mirrors.	Given scouring powder, glass cleaner, all-purpose cleaner, sponge, wiping cloths, and spray bottles, the student will be able to clean sinks and mirrors so that sinks and mirrors contain no dirt, streaks, or water spots.
E-76	Clean and sanitize rest room toilets and urinals.	Given bowl cleaner, bowl swab, wide-mouth container, and wiping cloths, the student will be able to clean and sanitize rest room toilets and urinals so that the toilets and urinals do not contain any stains or water spots and are wiped with a disinfectant.
E-77	Wash and spot-clean rest room walls and partitions.	Given spray bottles, sponge, wiping cloths, all-purpose cleaner, and a two-quart pail, the student will be able to wash and spot-clean rest room walls and partitions so that rest room walls and partitions do not contain any dust, smudges, streaks, or water spots.
E-78	Completely clean a rest room.	Given a broom, dust pan, bench brush, porcelain cleaner, bowl cleaner, swabs, glass cleaner, cleaning cloths, mop, two mop pails, one mop wringer, disinfecting solution, sponge, liquid soap for dispensers, and paper towel rolls, the student will be able to totally clean a rest room for one week (with inspections on completion of job each day) so that the floors, walls, ceilings, sinks, mirrors, urinals, and bowl are clean and free of all soil and water marks and so that the job can be done within one hour for each rest room.

INTERMEDIATE-LEVEL JOB TITLE: MAINTENANCE WORKER

At the intermediate level, the maintenance worker performs nonsupervisory (except for supervision of helpers) work involved in the maintenance and repair of grounds, exterior structures, buildings, and related fixtures and utilities. This work requires the use of a variety of trade practices associated with occupations such as carpentry, masonry, plumbing, electrical, air conditioning, cement work, painting, and other related trades.

The maintenance worker works from oral instructions, maintenance program plans, technical manuals, specifications and similar guides. The worker is expected to plan work sequences, select tools and materials, and otherwise carry assignments through to completion, referring to the supervisor as necessary for interpretation of manuals and the extent of work authorized. The worker is subject to spot checks during the progress and completion of work for compliance with instructions, specifications, and quality of work.

INTERMEDIATE-LEVEL TASKS

I-1 Consult with other departments to determine maintenance needs.

I-2 Carry out scheduled periodic inspections of structures, systems, or equipment.

I-3 Carry out scheduled periodic overhauls or replacements of parts of equipment or systems.

I-4 Investigate and determine causes of material or equipment failures.

I-5 Salvage usable parts from discarded equipment.

I-6 Receive requests from other departments for maintenance or repair work.

I-7 Transport materials or equipment to and from job sites, workshops, and storerooms.

I-8 Stand watches in power plant or boiler room.

I-9 Regulate operations of heating, air conditioning, and other systems.

I-10 Check operating condition of equipment by observation of water columns, pressure gauges, and meters.

I-11 Record temperatures, pressures, and other operational data.

I-12 Prepare boilers for service.

I-13 Clean valves, strainers, nozzles, and other boiler accessories.

I-14 Clean and lubricate pumps and other auxiliary equipment.

I-15 Replace valves, gauges, or meters.

I-16 Thread metal pipes.

I-17 Sharpen or repair tools or instruments.

I-18 Install pipes, valves, traps, vacuum breakers, and other fittings.

I-19 Inspect pipes and fittings for leaks, cracks, and corrosion.

I-20 Check operation of valves, traps, and other fittings.

I-21 Clean and lubricate valves, traps, and other fittings.

I-22 Repair leaks in piping and connections.

I-23 Replace defective pipes.

I-24 Repair or replace insulation on pipes and fixtures.

I-25 Clear stoppages in drain lines.

I-26 Repair or replace defective parts of plumbing fixtures.

I-27 Repair tank-flushing assemblies.

I-28 Repair leaks in valves, traps, or other fittings.

I-29 Replace washers or diaphragms.

I-30 Replace other parts of valves, traps, or other fittings.

I-31 Inspect and check pumps for pressure, packing, and alignments.

I-32 Clean and lubricate pumps.

I-33 Adjust or repair pumps by replacing packing, bearings, rings, or other parts.

I-34 Inspect radiators, convectors, and heating coils.

I-35 Check valves and connections of radiators, convectors, and heating coils.

I-36 Inspect other steam-using equipment in laundries and kitchens.

I-37 Check valves, traps, and exhaust lines of steam-using equipment.

I-38 Test and charge batteries.

I-39 Repair or replace lamps, ceiling panels, or other lighting fixtures.

I-40 Clean and lubricate motors and generators.

I-41 Adjust or repair machinery in kitchens, laundries, and shops.

I-42 Adjust or repair portable power tools.

I-43 Clean and lubricate motors, compressors, condensers, and other refrigerating and air-conditioning equipment.

I-44 Clean air washing or filtering equipment.

I-45 Clean air ducts, ventilators, fans, and hoods.

I-46 Replace air filters.

I-47 Adjust or repair grilles, dampers, and louvers.

I-48 Cut holes and passages for pipes and conduits.

I-49 Construct and install metal racks, railings, and shelves.

I-50 Adjust or repair metal furniture.

I-51 Remove snow and ice from buildings and grounds.

I-52 Check machinery guards and other protective devices or equipment.

I-53 Adjust or replace protective devices and equipment.

I-54 Participate in fire drill planning.

I-55 Direct attention of workers or supervisors to unsafe conditions or practices.

ADVANCED-LEVEL JOB TITLE: MAINTENANCE SUPERVISOR

The maintenance supervisor plans, schedules, and supervises maintenance and repair work of buildings, grounds, and utilities systems. This could include plumbing, masonry, carpentry, painting, electrical work, refrigeration, air conditioning, and gardening. The maintenance supervisor reads and interprets blueprints and manufacturer's specifications and requisitions equipment and materials for equipment installation, maintenance, or repair. The supervisor assigns maintenance workers or crews to specific jobs and spot-checks the work done to insure that it meets quality standards and that safety and building regulations are complied with. As an administrator, the supervisor may be responsible for controlling job costs and maintaining pertinent records. He or she may be responsible for personnel matters pertaining to the employment, training, termination, and grievances of maintenance workers.

ADVANCED-LEVEL TASKS

A-1 Participate in preparation of engineering and maintenance budgets.

A-2 Participate in determining specifications for new equipment or materials.

A-3 Participate in determining specifications for service or supply contracts.

A-4 Participate in planning of maintenance procedures and schedules.

A-5 Participate in planning of safety policies and procedures.

A-6 Prepare procedures manuals or guides.

A-7 Prepare charts, checklists, or worksheets for inspection and servicing of equipment.

A-8 Prepare and maintain equipment record cards.

A-9 Prepare directions for operation and maintenance of equipment by users.

A-10 Consult with administration in planning to meet needs for equipment and services.

A-11 Consult with other departments to determine maintenance needs.

A-12 Consult with utility services.

A-13 Consult with insurance agencies, fire departments, or other outside agencies.

A-14 Interview vendors of maintenance equipment.

A-15 Confer with inspectors from outside agencies to evaluate results of inspections.

A-16 Develop work-simplification and cost-reduction methods.

A-17 Evaluate performance of maintenance workers.

A-18 Interview and evaluate job applicants.

A-19 Develop and administer in-service training programs.

A-20 Instruct maintenance workers in new procedures and techniques.

A-21 Give instructions or demonstrations to users in operation and maintenance of equipment.

A-22 Keep records on inspection, servicing, and repair of structures, systems, and equipment.

A-23 Review records to check that prescribed inspection and maintenance schedules are being followed.

A-24 Keep records on fuel, water, and power consumption.

A-25 Maintain files of blueprints, diagrams, and specifications.

A-26 Receive and review inspection reports.

A-27 Analyze work requests.

A-28 Initiate actions to correct reported inspection defects.

A-29 Break down work into units by operations and/or crafts.

A-30 Estimate material and labor costs for jobs.

A-31 Consult with supervisors and foremen to plan and coordinate work schedules.

A-32 Consult with workers in planning procedures and selecting materials for jobs.

A-33 Assign priorities to jobs.

A-34 Prepare work orders for jobs.

A-35 Prepare work plans stating details of work to be performed and specifications for materials or equipment.

A-36 Prepare requisitions for materials, parts, and equipment.

A-37 Prepare diagrams, plans, or drawings of structures, systems, or equipment.

A-38 Review and approve work orders and work plans.

A-39 Review and approve requisitions for non-stock items.

A-40 Assign workers to jobs.

A-41 Arrange for availability of job sites, and notify appropriate persons of shut-downs of equipment or facilities.

A-42 Select outside contractors for jobs not performed by maintenance staff.

A-43 Visit job sites and inspect work in progress.

A-44 Supervise emergency repair work.

A-45 Supervise major construction, alteration, or repair work.

A-46 Inspect completed work.

A-47 Read and interpret blueprints, diagrams, and specifications.

A-48 Carry out scheduled periodic inspections of structures, systems, or equip-ment.

A-49 Carry out scheduled periodic overhauls or replacement of parts, equipment, or systems.

A-50 Investigate and determine causes of material or equipment failures.

A-51 Survey work or damaged equipment to determine if it should be repaired or replaced.

A-52 Receive requests from other departments for maintenance or repair work.

A-53 Participate in planning of emergency and disaster procedures.

A-54 Arrange for unsafe tools or equipment to be withdrawn from service.

SECTION 1.5
How to Develop Learning Activity Packages

The development of a performance-based curriculum for building maintenance training is based on a method called functional job analysis (described in Section 1.2). This method of analyzing actual job requirements as defined by employers is an effective way to develop a training curriculum. With this method, a training program curriculum contains the essential skills and knowledge that an entry-level worker performs on the job and leads to the development of an instructional system that describes **what, why,** and **how** the trainee is to learn these skills and knowledge.

This section explains how to take the job tasks and learning objectives presented in Section 1.4 and develop units of instruction, or learning activity packages (LAPs), from them. Two sample LAPs—one based on a job task and one based on the mathematical skills of approximation and estimation—are included as models that can be used to develop LAPs at the local level.

In addition to the information and sample LAPs presented here, which are specifically related to the building maintenance training program, the instructor should refer to the series of POP (Pre-Service Occupational Program) Kits available from the Illinois Office of Education. The POP Kits cover such instructional planning topics as student performance objectives, domains of learning, writing sets of objectives, lesson planning, constructing learning activity packages, and instructional materials.

Section 1.5, when used in conjunction with the POP Kits, provides the tools for building an instructional system based on the job tasks, learning objectives, and supplementary materials presented in this guide.

PRINCIPLES OF LEARNING

No matter what the content of a curriculum or the instructional methods used, there are several basic principles of learning that underlie the development of learning activity packages. The two sample LAPs presented later in this section are guided by these principles; it is strongly recommended that the seven principles of learning described below be kept in mind as LAPs are developed for the training program.

Optimum Step Size. Optimum step size involves the application of two concepts. First, students learn best when they are not frustrated by material that is too difficult. Second, students learn best when they are challenged beyond boredom. To apply these concepts, instruction is developed by increments, or steps, that are small enough to permit mastery without frustration but are large enough to provide meaningful challenge. Determining the optimum step size depends on several factors such as student background, intelligence, difficulty of material, and so on.

Controlled Responding. Not only is the instruction presented to the student in predetermined steps, but it also directs him or her to assume an active role by performing specific activities within each step. These activities are determined during the development of the learning activity package. It requires each student to apply what he or she learns as it is learned. This insures that the student progresses toward the learning objective. When controlled responding is built into the learning, the student becomes an active, rather than passive, participant in the learning experience.

Knowledge of Results. After responding overtly to each optimum step of instruction, the student

learns whether the response was correct or incorrect. Such knowledge of results, also known as confirmation, serves two purposes. Its primary purpose is to reinforce the learning process. When a student responds correctly and is told so, the learning of correct performance is reinforced and he or she is motivated toward further learning. Its secondary purpose is to correct wrong responses and thus prevent the student from practicing wrong performances. Without such timely knowledge of results, a student can repeat a mistake until it becomes part of his or her performance.

Controlled Pacing. In conventional instruction the training time is usually a constant factor. For example, if it has been decided that a specified amount of time will be spent on a segment of learning, then all students receive the specified amount of time regardless of differences in aptitude. We know from experience, however, that students learn at varying rates; but little provision is ever made for this obvious fact. By using LAPs, on the other hand, instruction time becomes a variable instead of a constant factor. If student self-pacing can be built into the learning situation, each student is allowed to progress at his or her own rate according to learning ability. If self-pacing is working effectively, the faster student is not held back and the slower student is not forced to rush in order to keep up. Controlled pacing confirms the learning activity package as the method that most practically achieves a balance between the needs of teaching and the requirements of learning. If individually paced learning is not practicable, then a group-paced approach can be used. In this approach, students are organized into homogeneous pacing groups so that each group can proceed at the appropriate learning rate.

Validation. Validation is the process of determining the effectiveness of instruction. It places the burden of teaching upon the system; if the students fail to achieve the objective of the learning activity package, one should assume that the instruction has failed. When such failure occurs, the instruction should be revised and restructured until the students achieve the learning objective.

Student-Centered Approach. The student-centered approach is one that incorporates all the previous principles in a comprehensive learning system. The final outcome of instruction is focused on student performance and measuring that performance. Learning is student-centered when the student has been taught through optimum steps, has been directed to respond, has been provided with knowledge of results, has progressed at his or her own rate, or within a rate appropriate to a particular homogeneous group, and when a careful analysis of the student's performance has been conducted.

Performance Analysis. The final product of a performance analysis includes: a complete, precise listing of the skills and knowledge that must be taught in order to prepare the student to master the objective; a determination of the conditions under which the student will perform; and the factors which constitute acceptable performance by the student. Performance analysis consists of a review of all performance objectives, field surveys, task observations, and any other process which yields empirical data about the actual performance the student is expected to demonstrate at the conclusion of a learning activity package. The analysis should involve only those skills and knowledge that are critical to performance of the task or achieving the objective. It should omit any material that is "nice-to-know," but not critical.

LEARNING ACTIVITY PACKAGES

The successful learning activity package is based on the comprehension, by the instructor and the student, of these four terms: objective, overview, learning experience, and summary.

The **objective** is the end result toward which student effort is directed in the package. It is stated in performance terms, which means that the student must demonstrate achievement of the performance specified. The objective states what the student should have learned at the completion of the LAP. The **overview** explains why it is important to achieve the stated objective and how it can benefit the student. The

learning experience guides the student through a step-by-step process to achieve the objective. The summary reviews the reason for doing the particular activity and reinforces the learning that has occurred during the LAP.

The key point of a learning activity package is, of course, the LAP's objective. The objective determines both the content and the activities of the LAP. The other components of the LAP, particularly the learning experiences, should support and satisfy the learning objective. Upon completion of the activities prescribed by the learning experiences, the student should be able to demonstrate the capability stated in the objective.

The learning experiences within the LAP should reflect the student capabilities necessary to satisfy the LAP's objective. The number of experiences and their content may vary from LAP to LAP. In fact, a given capability can, and should, be attained through different kinds of learning experiences. The instructor should be able to use various types of instructional methods (see Section 1.6) in order to provide students with appropriate learning experiences that will lead to mastery of the LAP objective.

In order to provide the student with first-hand exposure to vocational capabilities, emphasis must be placed on performance-based learning experiences—i.e., LAPs based on the tasks presented in Section 1.4. Performance-based activities permit the student to utilize both cognitive and psychomotor processes in achieving the objectives of a learning activity package. They also provide the instructor and student with the opportunity to evaluate the attainment of vocational capabilities.

Non-performance activities, to be sure, have their value; but these activities alone cannot provide the student with the capabilities which he or she will need on the job in the working world. In addition, many students are at relatively low reading and vocabulary levels; this casts doubt on how much the student really learns through these methods. There is also a question if portions of theories, principles, or concepts are really needed by the student to achieve given capabilities at a particular level or if they are needed at all. Determining how much theory and how much practice is to be included in a learning activity package is sometimes a difficult process. Very often, however, a clear statement of the LAP's objective will provide the answer.

Another factor to be considered in developing LAPs involves the selection of appropriate reference materials and teaching-learning aids. This requires a consideration of a number of factors, such as the relevance of the information, the ability of the student to benefit from it, and its availability, cost, and ease of use. These must be evaluated continually since the criteria for their selection may change from LAP to LAP. Section 1.7 lists reference materials and teaching aids which the instructor should find useful in developing learning activity packages.

DEVELOPING LAPS FROM A TASK

In Section 1.1 of the guide you followed a series of steps in order to specify the content of the training program. The result of this process was a sequenced list of performance-based tasks and their associated learning objectives. The steps below show one way to identify the skills, knowledge, and activities related to each task that can be used to develop one or more learning activity packages.

To help you work through these steps, three worksheets are provided on the following pages. (Blank worksheets are provided at the end of this section for duplication and use by the instructor.) Steps 1-6 explain Worksheets 1 and 2 and help you to gather and organize the information needed to develop a LAP. Worksheet 1, "Task Listing," involves selecting a task for instruction and identifying tasks that are related to the selected task. Worksheet 2, "Task Analysis," is used for breaking down a task into the skills and knowledges required to perform the task. Steps 7-11 explain Worksheet 3, "LAP Outline," which is used for organizing the information developed on Worksheets 1 and 2 into a learning activity package outline.

STEP 1: Select a task for instruction.

From your list of sequenced tasks, select one task for instruction. Write this task down in the space provided on Worksheet 1. For the sample LAP presented in this section, the following task was selected: "Clean, seal, wax, and buff a resilient floor."

STEP 2: Identify tasks that are closely related to the task selected in Step 1.

Although you are working with only one task at a time, it is important to identify those tasks that are closely related to the task you selected. By completing this step, you will establish interrelationships among a group of tasks. Write down these tasks in the spaces provided on Worksheet 1. Examine these tasks and how they are related to one another. This helps to establish a sequence for other learning activity packages that you will develop.

STEP 3: Specify the learning conditions and outcomes of the task to be performed by the student.

Moving on to Worksheet 2, write down the task, the learning conditions under which the task will be performed by the student, and the outcomes which will be used to evaluate student performance. For the sample LAP, the learning conditions are: "Three mops, three pails, two wringers, stripping solution, sealer, wax, wet vacuum, floor machine, wire brush, scrubbing pad, and buffer pad." The outcome by which student performance will be judged is: "The floor is free of all dirt and has a high luster."

STEP 4: Break down the task into learning activities.

The task you have selected should now be broken down into more manageable components—learning activities. List these activities in the spaces provided on Worksheet 2.

STEP 5: Break down each activity into specific steps.

On Worksheet 2 each activity has been broken down into a series of steps. For example, under the activity of "Clean a resilient floor" eight steps have been listed. For each of the other four learning activities, a similar sequenced list of steps has been generated on Worksheet 2.

STEP 6: Identify the knowledges which support the performance of each activity.

The final component of Worksheet 2 is a listing of the knowledges which support the performance of the steps under each activity. For example, in cleaning a resilient floor it is important for the maintenance worker to have a knowledge of standard instructions for damp mopping. The supporting knowledges are listed below the series of steps for each activity identified on Worksheet 2.

Steps 1-6 above have helped you to gather and organize the information needed for the development of LAPs related to a single task statement: "Clean, seal, wax, and buff a resilient floor." All of this information has been entered on Worksheets 1 and 2. Steps 7-11 explain how to take the information from Worksheets 1 and 2 and develop an outline for a single learning activity package.

STEP 7: Select one learning activity from Worksheet 2 as the content for a single LAP.

In the sample provided in this section, the learning activity "Clean a resilient floor" has been selected as the content for a learning activity package. The other four learning activities identified can be used for the development of subsequent LAPs. The intent of selecting just one learning activity is to narrow the focus of instruction into manageable units. Enter the activity name and the steps into which it has been broken down in the spaces provided on Worksheet 3.

STEP 8: Write the objective for the LAP.

On Worksheet 2 the learning conditions and the performance outcome were identified for the task statement as a whole. Using this information as a foundation, write the LAP objective as it pertains to the specific learning activity you selected. For the tasks listed in Section 1.4, the learning objectives have already been provided. It is important to remember that any learning objective is made up of these two parts—the learning conditions and the performance outcome. The objective is a statement of what the student will be able to do at the completion of the LAP. On Worksheet 3 the objective of the sample LAP has been stated as: "Given three mops, three pails, and two wringers, the student will be able to clean a resilient floor so that the floor is free of all dirt."

STEP 9: Write an overview to the LAP.

The overview provides a general introduction to the LAP, explains the importance of the LAP's objective, and how it can benefit the student. It also serves as a link to other kinds of tasks that have already been taught or will be taught in subsequent LAPs (see Worksheet 1). Writing the overview is an important step in LAP development, because it requires the instructor to focus his or her attention on what is to be learned during this particular LAP. Review the sample overview on Worksheet 3 to see how this is accomplished.

STEP 10: List learning experiences for the LAP.

Learning experiences should take into account all of the steps listed at the top of Worksheet 3. In preparing a LAP outline, list the learning experiences that are needed to deal with each step and that will accomplish the objective. For the sample unit these are listed in the space provided under "Learning Experiences."

STEP 11: Write a summary of the LAP.

The summary provides a review of the outcome of the learning experiences in order to reinforce the learning that has taken place during the LAP. Space is provided on Worksheet 3 to write this summary.

Worksheet 1

TASK LISTING

Job: Maintenance Helper

Task: Clean, seal, wax, and buff a resilient floor.

Related Tasks:

1. Remove dirt and grease from resilient or hard floors by wet mopping.
2. Wax a floor.
3. Remove solutions from floors.
4. Strip or light scrub a floor using an automatic floor machine.
5. Operate a floor machine.
6. Spray buff a floor.
7. Seal a resilient floor.
8. Seal a new wood floor.
9. Seal and finish an old floor.
10. Care for hard-surfaced floors.

Worksheet 2

TASK ANALYSIS

Job: Maintenance Helper

Task: Clean, seal, wax, and buff a resilient floor.

Learning Conditions: Three mops, three pails, two wringers, stripping solution, sealer, wax, wet vacuum, floor machine, wire brush, scrubbing pad, and buffer pad.

Outcome: The floor is free of all dirt and has a high luster.

Learning Activity: Clean a resilient floor using standard practice.

Steps:

1. Remove all furniture and objects from the room.
2. Dust mop entire room until no dirt is visible.
3. Remove dirt collected by dust mopping with bench brush and dust pan and dump in trash receptacle.
4. Refresh your memory on how to mop by referring to the instructions on damp mopping.
5. Fill bucket two-thirds full with cold water. Add the required number of ounces of neutral soap for each gallon of water.

Worksheet 2 – Continued
TASK ANALYSIS

Steps:

6. Bring your equipment to the work area and begin mopping.

7. When wet mopping a high traffic area you may need to go over it a second time to remove all the dirt and grease.

8. When finished, clean your equipment according to the instructions on damp mopping.

9.

10.

11.

12.

Supporting Knowledge Required: Instructions on damp mopping.

Learning Activity: Wax a resilient floor using standard procedure.

Steps:

1. Prepare floor for waxing; dust, mop, wet mop, damp mop, strip and/or seal.

2. Pour wax into mop bucket to a depth of about four inches.

3. Place mop into the wax and carefully place the dripping mop into the wringer, slowly tightening the handle of the wringer. When bringing the mop out of the wringer it should not be dripping.

4. Begin waxing by carefully applying the wax along the outer edge of an area and around any unmoved furniture.

5. Apply wax to area using the procedures described in damp mopping ("figure eight" method).

Steps:

6. Place the mop into wax and wring it out as often as necessary to maintain an even appearance.

7. Apply succeeding coats in the same manner except that these applications should be kept at least six inches away from the baseboards.

8.

9.

10.

11.

12.

Supporting Knowledge Required: Instructions on waxing provided by supplier or instructor-designated source.

Learning Activity: Buff a resilient floor using standard procedure.

Steps:

1. Take equipment to the work area.
2. Place both hands on the handle and tilt machine so handle rests on floor.
3. Attach buffing pad to brush.
4. Attach brush to floor machine by placing the brush place on the drum (the slots in the brush place correspond to those on the machine); rotate until brush is secure.
5. Place machine in upright position.

Steps:

6. Adjust handle to about waist level and secure handle. Plug in the machine.

7. Place both hands on machine handle and grasp securely.

8. By slightly lifting on the handle, the machine will automatically move to your right. Pushing down on the handle will move the machine to the left.

9. Practice moving the machine from side to side until you can do it with ease.

10. Continue this operation until floor has been buffed.

11.

12.

Supporting Knowledge Required: Instructor-designated source of instructions.

Learning Activity: Use an automatic floor machine according to standard practice.

Steps:

1. Fill the solution tank with warm water and add the proper amount of wax remover according to directions on the container.

2. Place stripping pads on brushes and attach to machine.

3. Make sure pick-up tank is empty, squeegee blade is clean, and all hose connections are secure.

4. Fill two buckets half full with cold water. Add wringers and mops.

5. Move your equipment to the job area.

Steps:

6. An automatic floor machine is used mostly for open areas. Therefore, start at the outside of the area to be done and work toward the center.

7. Set solution control lever to the desired amount.

8. Set brush pressure to the desired amount; usually at about normal pressure.

9. Lower squeegee blade and turn vacuum motor on.

10. Lower brushes, turn machine on, and begin moving machine in the same motion. Never leave machine idle with the brushes running.

11. Run the machine over the entire area to be done.

12. Use the steel wool kick pad for edges and corners.

13. Rinse entire area to pick up any excess water.

Ste... 14. If the floor is especially dirty you may run the machine without the squeegee and vacuum the first time over the floor. Then go over the floor a second time with the squeegee, vacuum, and brushes, but without adding extra water to the floor.

15. Light scrubbing. The methods are the same as in stripping except: (a) use a light scrub pad, (b) use cold water with a light scrub soap, (c) use less brush pressure, (d) go over the floor only once with the machine.

16. Clean the machine after using it: (a) empty solution and pick-up tank and hose, (b) fill batteries to the desired level, (c) lubricate when necessary according to the operating manual, (d) do not leave squeegee down when automatic is not in use, (e) clean battery cables, (f) remove and clean vacuum motor filter, (g) plug in battery charger.

Supporting Knowledge Required: Instructions on use of automatic floor machine.

Worksheet 2 – Continued
TASK ANALYSIS

Learning Activity: Seal a resilient floor using standard practice.

Steps:

1. Strip and rinse floor.

2. Take equipment and seal to work area.

3. Work at point furthest from your exit (when applicable).

4. Pour seal into mop bucket to a depth of about four inches.

5. Place clean mop in seal. Dip mop up and down several times to be certain mop has seal all over it.

Steps:

6. Place mop in wringer and tighten handle lightly.

7. Apply seal to an area of about 25 square feet.

8. Return to bucket and wringer and wring out mop; tighten wringer handle as far as possible.

9. With mop, pick up excess seal from the floor.

10. Repeat Steps 6 through 9 until entire floor has been sealed.

11.

12.

Supporting Knowledge Required: Instructions and directions found on industrial materials.

Worksheet 3

LEARNING ACTIVITY PACKAGE OUTLINE

Job: Maintenance Helper

Task: Clean, seal, wax, and buff a resilient floor.

Learning Activity: Clean a resilient floor using standard practice.

Steps:

1. Remove all furniture and objects from the room.
2. Dust mop entire room until no dirt is visible.
3. Remove dirt collected by dust mopping with bench brush and dust pan and dump in trash receptacle.
4. Refresh your memory on how to mop by referring to the instructions on damp mopping.
5. Fill bucket two-thirds full with cold water. Add the required number of ounces of neutral soap for each gallon of water.
6. Bring your equipment to the work area and begin mopping.
7. When wet mopping a high traffic area you may need to go over it a second time to remove all the dirt and grease.
8. When finished, clean your equipment according to the instructions on damp mopping.

Supporting Knowledge Required: Instructions on damp mopping.

Worksheet 3 – Continued
LEARNING ACTIVITY PACKAGE OUTLINE

LAP Objective: Given three mops, three pails, and two wringers, the student will be able to clean a resilient floor so that the floor is free of all dirt.

Overview: Establish the relationship of this learning activity to general maintenance floor care tasks (see Worksheet 1: Task Listing). Show the relationship of the learning activity to the learning objective for this LAP. Develop a sequence of activities to achieve the LAP objective.

Learning Experiences:

1. Demonstrate proper floor cleaning techniques.
2. Show a film illustrating proper floor cleaning techniques.
3. Have students follow job steps listed above.
4. Have students actually clean a resilient floor under supervision.
5. Have students read about floor cleaning techniques and procedures in a standard maintenance manual or textbook.

Worksheet 3 – Continued

LEARNING ACTIVITY PACKAGE OUTLINE

Summary: Review each of the steps in the learning activity so that student learning is reinforced.

EVALUATING STUDENT PERFORMANCE

On the next page is offered one method for evaluating student performance on the LAP described above. The Student Evaluation Checklist is based on observing the performance of the student for each step of the learning activity. The learning activity can be designated as one that requires limited skill (L), moderate skill (M), or proficiency (P). As the student performs each step in the LAP, the instructor can rate the student's performance as either satisfactory (S) or unsatisfactory (U). This is an easy way to keep track of each student's performance on LAPs presented over a period of time. It also offers the instructor a means of determining which skills have been mastered and which skills have not been mastered by the student group as a whole. By reviewing these checklists periodically, the instructor can pinpoint the areas of instruction in which students need additional help. (A blank Student Evaluation Checklist is provided at the end of this section for duplication and use by the instructor.)

STUDENT EVALUATION CHECKLIST

Key:	L = Limited skill M = Moderate skill P = Proficiency S = Satisfactory U = Unsatisfactory

Student Name: _____

Date: _____

Instructor: _____

RATING			CRITERIA	
L	M	P	Learning Activity:	Clean a resilient floor using standard practice.
	S	U	Steps: 1.	Remove all furniture and objects from the room.
	S	U	2.	Dust mop entire room until no dirt is visible.
	S	U	3.	Remove dirt collected by dust mopping with bench brush and dust pan and dump in trash receptacle.
	S	U	4.	Refresh your memory on how to mop by referring to the instructions on damp mopping.
	S	U	5.	Fill bucket two-thirds full with cold water. Add required number of ounces of neutral soap for each gallon of water.
	S	U	6.	Bring your equipment to the work area and begin mopping.
	S	U	7.	When wet mopping a high traffic area you may need to go over it a second time to remove all the dirt and grease.
	S	U	8.	When finished, clean your equipment according to the instructions on damp mopping.

DEVELOPING LAPS FROM A GENERAL KNOWLEDGE CONCEPT

On the following pages is a sample LAP based on the general knowledge concept of "approximation and estimation." Again, the LAP's four components—objective, overview, learning experiences, and summary—are presented in detail. This LAP is one that students work through on their own with a minimum of interaction with the instructor.

(SAMPLE LEARNING ACTIVITY PACKAGE
BASED ON A GENERAL KNOWLEDGE CONCEPT)

LEARNING ACTIVITY PACKAGE 1:
APPROXIMATION AND ESTIMATION

OBJECTIVES

When you have completed this unit, you will be correct 85% of the time when you:

1. identify whether numbers in a list are exact or approximate.
2. list reasons why a number is approximate.
3. identify the maximum error, as a tolerance, of measurements you have made.
4. rewrite a list of measurements so that they all are of the same precision.
5. measure an object to a certain degree of precision (tolerance).
6. state the relative error and degree of accuracy of a measurement.
7. round off measurements and numbers to a specified place.
8. estimate a sum, difference, product or quotient to within 10% of the actual value.

OVERVIEW

It is impossible to exactly measure anything. There is always some amount of error in any measurement you make. In everyday life when you make measurements it is often necessary to tell how much in error your measurement is. In this learning activity you will learn about different types of errors and how to let other people know about them when they appear in your work. (The prerequisites for this LAP are satisfactory completion of the LAPs on Base 10, Number Line, Whole Numbers, Fractions, Decimals, Reciprocals, Measurement, Metric System, Averages, Percent, Ratio and Proportion, Square Roots, and Laws of Indices.)

DIAGNOSTIC PRETEST

1. Which of the following are approximate measures? Circle the letter appearing before the measure if it is approximate.

   a. Baseball score: Pittsburgh 3, Chicago 2

   b. Enrollment of Plainview High School: 478 pupils

   c. Springfield area rainfall for 1967: 24.3 inches

   d. World's record for the 100-yard dash: 9.1 seconds

   e. Automobiles manufactured during the month of August at the Dearborn plant: 1,463

2. For each approximate measure in Question 1, write two reasons why it is an approximate measure and not an exact measure.

   _____

   _____

   _____

   _____

   _____

3. Write the maximum error, as a tolerance, for the following measurement:

   249.10 inches maximum error = _____

4. Rewrite the following measurements so that they are all of the same precision as the example:

   Example: $4\frac{3}{4}$ inches

   a. $6\frac{12}{16}$ inches = _____

   b. 2.500 inches = _____

   c. 3.000 inches = _____

   d. $5\frac{2}{8}$ inches = _____

5. Measure the diameter of a 25-cent piece to the nearest $\frac{1}{16}$ inch:

_____

6. State the relative error, correct to two decimal places, for the measurement made in Question 5:

_____

7. State the degree of accuracy, to the nearest whole percent, of the measurement made in Question 5:

_____

8. Round off these numerals to the stated number of decimal places:

	Numeral	Places	Rounded-Off Numeral
a.	14.145	1	_____
b.	69.937	0	_____
c.	2410.005	2	_____
d.	3.14159	4	_____

9. Estimate the product of 710 and 45:

_____

Check your answers with the teacher.

LEARNING EXPERIENCES

As you work through the learning experiences, check your answers in the answer section at the back of this package. If you do not understand any of the questions or the answers, ask your teacher for help.

1. Choose a partner to work with you on these questions.

2. Each of you take a separate sheet of paper and independently (this means you should not show one another the piece of paper or talk over what you are doing until you are told to do so):

   a. with a yardstick, measure to the nearest 1/16" the length of the same window pane in your classroom.

   b. with a yardstick, measure to the nearest 1/16" the width of the same window pane in your classroom.

   c. with a yardstick, measure to the nearest 1/16" the height of the same supply cabinet in your classroom.

   d. count the number of students present in your classroom today.

   e. count the number of desk chairs that are in your classroom.

   Write each measurement or count on your piece of paper.

3. After both of you have measured and counted EVERYTHING in Question 2, compare your lists. Circle two of the five things you did which agree most completely on the two lists:
   a, b, c, d, e.

4. List all the reasons you can think of why the other three measurements did not agree completely between the two lists.

   _____

   _____

   _____

   _____

   _____

5. Make each statement true by crossing out the wrong word.

   a. Exact/approximate numbers are the result of measurements.

   b. Exact/approximate numbers are the result of counting.

6. Which of the following are exact or counted measures and which are approximate? Circle the correct choice.

a.	baseball score	exact, approximate
b.	enrollment of your school	exact, approximate
c.	annual rainfall in Pennsylvania	exact, approximate
d.	time to run 50 yards	exact, approximate
e.	tickets sold for the football game	exact, approximate
f.	tractors manufactured in May	exact, approximate

7. Which sources of error from the following list could account for one of the measures in Question 6 being approximate? Write the letter of the measurement from Question 6 after the source of error.

   a. poor eyesight _____

   b. lack of skill _____

   c. lack of experience _____

   d. haste _____

   e. expecting a certain value _____

   f. temperature _____

   g. weather conditions _____

   h. vibration _____

   i. jarring of measuring instrument _____

   j. unexpected strain on measuring instrument _____

   k. bad design of measuring instrument _____

   l. careless calibration of measuring instrument _____

   m. zero error—instrument does not read zero when not measuring anything _____

   n. matching the position of the ends of a measuring stick when the length to be measured is longer than the size of the stick _____

   o. parallax-eye, instrument scale, and object are not properly aligned _____

8. Write a brief definition of what you think "precision" is when it pertains to measurement.

_____

_____

_____

Write a brief definition of what you think "accuracy" is when it pertains to measurement.

_____

_____

_____

Precision

Rule: "The smaller the unit of measurement, the more precise the measurement."

9. Circle the most precise measurement in each series.

a. 1" 1' 1 yd.

b. 1" 10" $\frac{1}{2}$" 1'

c. $\frac{1}{2}$" $\frac{2}{4}$" $\frac{4}{8}$"

d. $5\frac{13}{16}$" $5\frac{6}{8}$" $3\frac{2}{4}$" 7"

10. Rewrite the measurements in Question 9, part d, so that they are all of the same degree of precision. (Hint: 7" may be written as $7\frac{0}{16}$".)

Maximum Error

11. Precision may also be indicated as a TOLERANCE, or by stating the MAXIMUM ERROR of a measurement.

Both maximum error and tolerance depend on the smallest unit or mark that is on the scale of your measuring instrument.

a. What is the smallest unit of measure on Scale M? _____

Scale M:

Using Scale M, measure the length of each of the following line segments:

X _____
Y _____
Z _____

b. X = _____

c. Y = _____

d. Z = _____

12. If line segment X were $\frac{1}{8}$" shorter, how long would it be compared to Scale M?

_____

13. If line segment Z were $\frac{1}{8}$" longer, how long would it be compared to Scale M?

_____

14. A line segment that is $1\frac{1}{2}$" long would include all line segments from 1 — to 1 — on Scale M.

15. A line segment $1\frac{1}{2}$" long could be at most _____ inches shorter or longer than $1\frac{1}{2}$" on Scale M.

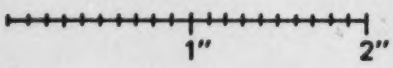
16. This length from Question 15, or one-half the smallest unit or place value of the measurement, is the MAXIMUM ERROR of the unit.

What is the maximum error of:

$1\frac{1}{2}$" _____

1.5" _____

17. When you find the maximum error of measurements expressed as decimals you must take one-half of the smallest place value. Thus the maximum error of 1.5" is NOT .25". It is .05", as shown below:



Scale is divided into $\frac{1}{10}$" units.

18. Fill in the blanks:

		Smallest unit or place value	Maximum error
a.	$1\frac{1}{4}$ inches	_____	_____
b.	1.3 inches	_____	_____
c.	$9\frac{5}{8}$ inches	_____	_____
d.	12.68 feet	_____	_____
e.	$4\frac{0}{16}$ inches	_____	_____
f.	3 hours 13 minutes	_____	_____

Tolerance

19. Tolerance is a way of expressing the maximum error along with the measurement.

The maximum error of $\frac{1}{4}$" of a measurement of $1\frac{1}{2}$" is expressed in tolerance form:

$$1\frac{1}{2} \pm \frac{1}{4}"$$

20. Rewrite the measurements in Question 18 with their maximum error expressed in tolerance form.

a. _____ d. _____

b. _____ e. _____

c. _____ f. _____

21. Suppose you measured a line to the nearest $\frac{1}{4}$" and found the measurement closer to 5" than to $4\frac{3}{4}$" or $5\frac{1}{4}$".

Why would you record the measurement as $5\frac{0}{4}$" instead of 5"?

_____

_____

_____

Accuracy

22. Take a piece of cardboard which is 3" long and mark one edge off into half inches. Using this new rule, measure the following to the nearest half inch:

a. the diameter of your pencil _____"

b. the width of the arm of your desk chair _____"

c. the height of the blackboard _____"

23. What is the maximum error of each measurement? _____

24. Are all the measurements in Question 22 equally precise? _____

25. In Question 22, there is one measurement where the maximum error is more important for accuracy. Which is it: a, b, or c ? (Circle one.)

26. The diameter of the pencil is small compared to the maximum error of the instrument. This means that we will not get an accurate measurement of the diameter no matter how often we measure it.

27. As the size of the object we measured increased, the size of the maximum error became less important. We use the term "relative error" to describe how important this relationship is.

The formula for relative error is:

$$\text{Relative Error} = \frac{\text{Maximum Error}}{\text{Recorded Measurement}}$$

28. Calculate the relative error for b and c of Question 22.

relative error for b _____

relative error for c _____

29. Explain in your own words what the term "relative error" means.

_____

_____

_____

30. In Question 28, which relative error is larger: b or c ? (Circle one.)

31. Based on the size of relative errors, which measurement in Question 28 was more accurate: b or c ? (Circle one.)

32. The size of a relative error indicates how accurate your measurement was. Make this sentence true by circling the correct word.

"One measurement is more accurate than another if it has a larger / smaller relative error."

33. Look at the formula for relative error in Question 27. In order for you to reduce the relative error, it is necessary for you to change only one of the other two components of the formula. Which one would you change and how would you change it (make it larger, smaller, etc.)?

_____

_____

_____

34. A "degree of accuracy" may be found by changing the relative error into a percent, and then subtracting this from 100. An acceptable degree of accuracy for most measurements is 95%.

Convert the relative errors in Question 28 into degrees of accuracy.

degree of accuracy for b _____

degree of accuracy for c _____

Rounding Off

35. To avoid all confusion when rounding off numbers, use this rule: "If the left-most digit of the part of the number to be dropped is a 0, 1, 2, 3 or 4, drop this whole part of the number."

Example: Round off 6.149 to one decimal place. Answer: 6.1

Round off these numbers to one decimal place:

a. 6.103 _____

b. 6.113 _____

c. 6.123 _____

d. 6.133 _____

e. 6.143 _____

36. Another rule to follow when rounding off numbers is: "If the left-most digit of the part of the number to be dropped is a 5, 6, 7, 8 or 9, drop this whole part of the number and add one (1) to the final digit retained."

Example: Round off 6.159 to one decimal place. Answer: 6.2

Round off these numbers to three decimal places:

a. 6.28509 _____

b. 6.28519 _____

c. 6.28529 _____

d. 6.28539 _____

e. 6.28549 _____

f. 6.28559 _____

g. 6.28569 _____

h. 6.28579 _____

i. 6.28589 _____

j. 6.28599 _____

Estimation

37. Accurate estimation requires the ability to round off numbers correctly. Estimation also implies that you are going to add, subtract, multiply or divide numbers. All of the following estimations can be made using the same technique:

"Estimate the sum of 1981 and 344."
"Estimate the difference of 1981 and 344."
"Estimate the product of 1981 and 344."
"Estimate the quotient of 1981 divided by 344."

38. Estimate the following answers:

a. The sum of 2000 and 300 is _____.

b. The difference of 2000 minus 300 is _____.

c. The product of 2000 and 300 is _____.

d. The quotient of 2000 divided by 300 is _____.

39. What change was made to the numbers used in Question 37 that resulted in the numbers used in Question 38?

_____

_____

_____

40. Every time you round off numbers that you have to add, subtract, multiply or divide so that you are working with round numbers that consist of a single, non-zero digit and zeros, you should be accurate to within 10% of the actual answer.

List three situations where you could apply this principle:

a. _____

b. _____

c. _____

CRITERION POSTTEST

1. Circle the letter appearing before the measure if it is an approximate measure:

   a. Football score: Kansas City 29, St. Louis 6

   b. Enrollment of Baylor Junior High School: 682 pupils

   c. Rockford area snowfall for 1966: 18.0 inches

   d. World's record for the mile: 3 minutes 51 seconds

   e. Trawlers manufactured during the month of September at the Quincy shipyards: 6

2. For each approximate measure in Question 1, write at least two reasons why it is an approximate measure and not an exact measure.

   _____

   _____

   _____

   _____

   _____

3. Write the maximum error, as a tolerance, for the following measurement:

   8.63 seconds maximum error = _____

4. Rewrite the following measurements so that they are all of the same precision as the example:

   Example: 2.20 seconds

   a. $6\frac{1}{5}$ seconds = _____

   b. 4.859 seconds = _____

   c. $9\frac{0}{5}$ seconds = _____

   d. 1.1 seconds = _____

5. Measure the diameter of a 5-cent piece to the nearest $\frac{1}{16}$ inch:

_____

6. State the relative error, correct to two decimal places, for the measurement made in Question 5:

_____

7. State the degree of accuracy, to the nearest whole percent, for the measurement made in Question 5:

_____

8. Round off these numerals to the stated number of decimal places:

	Numeral	Places	Rounded-Off Numeral
a.	8.1818	3	_____
b.	4.067	0	_____
c.	3.333	1	_____
d.	1.2121	2	_____

9. Estimate the quotient of 39,673 divided by 54:

_____

Check your answers with the teacher.

SUMMARY

In this unit you have learned something about types of errors that appear in measurements, some that you would like to reduce or eliminate, and others that you want to make on purpose such as in rounding off or in estimating. Whenever you must add, subtract, multiply, or divide measurements you may increase your errors unless you know what to do and exactly when to round off.

REFERENCES

1. Glenn, W. H., & Johnson, D. A. Invitation to mathematics. Garden City, N.Y.: Doubleday,

2. Larsen, H. D., & Ludlow, H. G. Arithmetic for colleges. New York: Macmillan, 1963.

3. Rassweiler, M., & Harris, J. M. Mathematics and measurements. Dubuque, Ia.: Wm. C. Brown Book Co., 1962.

ANSWER KEY FOR QUESTIONS 1–40

1. No answer.

2. Varies with the size of the objects.

3. d, e

4. Different for each student—accept, if logical.

5. a. approximate
   b. exact

6. a. exact
   b. exact
   c. approximate
   d. approximate
   e. exact
   f. exact

7. c and d should appear after all except n.

8. Different for each student.

9. a. 1"
   b. $\frac{1}{2}$"
   c. $\frac{4}{8}$"
   d. $5\frac{13}{16}$"

10. $5\frac{13}{16}$" $5\frac{12}{16}$" $3\frac{8}{16}$" $7\frac{0}{16}$"

11. a. $\frac{1}{2}$"

b. $1\frac{1}{2}$"

c. $1\frac{1}{2}$"

d. $1\frac{1}{2}$"

12. 1"

13. 2"

14. $\frac{1}{4}$" $\frac{3}{4}$"

15. $\frac{1}{4}$"

16. $\frac{1}{4}$" .05"

17. No answer.

18. a. $\frac{1}{4}$" $\frac{1}{8}$"

b. .1" .05"

c. $\frac{1}{8}$" $\frac{1}{16}$"

d. .01' .005'

e. $\frac{1}{16}$' $\frac{1}{32}$"

f. 1 minute 30 seconds, or .5 minutes

19. No answer.

20. a. $1\frac{1}{4} \pm \frac{1}{8}$"

b. $1.3 \pm .05$"

c. $9\frac{5}{8} \pm \frac{1}{16}$"

d. $12.68 \pm .005'$

e. $4\frac{0}{16} \pm \frac{1}{32}$"

f. 3 hours 13 minutes $\pm$ 30 seconds

21. $5\frac{0}{4}$" shows that the measurement was made to the precision of $\frac{1}{4}$", which is correct. 5" implies the measurement was made to a precision of 1", which is incorrect.

22. Varies with the size of the objects.

23. $\frac{1}{4}$"

24. Yes

25. a

26. No answer.

27. No answer.

28. Varies with the size of the object.

29. Different for each student. Could be "Relative error describes the relationship (or compares the sizes) of the maximum error of a measurement and the measurement itself."

30. b

31. c

32. Smaller

33. Maximum error—make it smaller by measuring to a greater precision.

34. Varies with the size of the object.

35. a. 6.1 d. 6.1
    b. 6.1 e. 6.1
    c. 6.1

36. a. 6.285 f. 6.286
    b. 6.285 g. 6.286
    c. 6.285 h. 6.286
    d. 6.285 i. 6.286
    e. 6.285 j. 6.286

37. No answer.

38. a. 2300 b. 1700 c. 600,000 d. 6 (approximately)

39. They were rounded off to one digit. The digits dropped were replaced by zeros.

40. Different for each student.

WORKSHEETS

On the following pages are blank worksheets and a student evaluation form which can be duplicated and used for developing learning activity packages for your building maintenance training program.

Worksheet 1

TASK LISTING

Job: _____

Task: _____

_____

Related Tasks:

1. _____

_____

2. _____

_____

3. _____

_____

4. _____

_____

5. _____

_____

6. _____

_____

7. _____

_____

8. _____

_____

9. _____

_____

10. _____

_____

Worksheet 2

TASK ANALYSIS

Job: _____

Task: _____

_____

Learning Conditions: _____

_____

_____

Outcome: _____

Learning Activity: _____

Steps: 1. _____

_____

_____

2. _____

_____

_____

3. _____

_____

_____

4. _____

_____

_____

5. _____

_____

_____

Worksheet 2 – Continued
TASK ANALYSIS

Steps: 6. _____

7. _____

8. _____

9. _____

10. _____

11. _____

12. _____

Supporting Knowledge Required: _____

Worksheet 2 – Continued
TASK ANALYSIS

Learning Activity: _____

Steps:

1. _____
2. _____
3. _____
4. _____
5. _____

Worksheet 3

LEARNING ACTIVITY PACKAGE OUTLINE

Job: _____

Task: _____

_____

Learning Activity: _____

Steps: 1. _____

_____

2. _____

_____

3. _____

_____

4. _____

_____

5. _____

_____

6. _____

_____

7. _____

_____

8. _____

_____

Supporting Knowledge Required: _____

_____

_____

Worksheet 3 – Continued

LEARNING ACTIVITY PACKAGE OUTLINE

LAP Objective: _____

_____

_____

Overview: _____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Learning Experiences:

1. _____

_____

2. _____

_____

3. _____

_____

4. _____

_____

5. _____

_____

Worksheet 3 – Continued

LEARNING ACTIVITY PACKAGE OUTLINE

Summary: _____

_____

_____

_____

_____

_____

_____

_____

_____

_____

STUDENT EVALUATION CHECKLIST

Key:	L = Limited skill
	M = Moderate skill
	P = Proficiency
	S = Satisfactory
	U = Unsatisfactory

Student Name: _____

Date: _____

Instructor: _____

RATING	CRITERIA
L M P	Learning Activity: _____
S U	Steps: 1. _____
S U	2. _____
S U	3. _____
S U	4. _____
S U	5. _____
S U	6. _____
S U	7. _____
S U	8. _____

SECTION 1.6
How to Select an Instructional Method

A better understanding of how people learn and the evolution of modern teaching and learning aids have resulted in the development of a variety of instructional methods. This section discusses eight of the most commonly used methods: lecture, conference, demonstration, performance, programmed instruction, study assignment, tutoring, and a combination of any of these.

Every instructional method has certain advantages and disadvantages, so it is important that the method selected is the one which will be most effective and efficient. Choosing an instructional method must be based on a careful analysis of the factors involved in the learning situation: instructional objectives, course content, student population, instructor, facilities, equipment, instructional materials, time, and costs. This section describes these factors as they relate to each of the eight instructional methods.

SELECTING AN INSTRUCTIONAL METHOD

Except for the selection of training objectives, the proper selection of instructional methods will do more to promote instructional efficiency and effectiveness than any other measure. Many times this fact is overlooked in training and education. All too often the selection of instructional methods is dictated by expediency rather than choice. An instructional method or methods must be selected through systematic means if inefficiency in attaining the course objectives—or worse, failure to achieve objectives—is to be avoided.

There is no single best method of teaching which applies to all learning situations or instructional objectives. The instructor must choose the method that is most compatible with the instructional objectives, the nature of the school organization, the facilities and equipment available, the background and level of the students, and the instructor's own abilities.

Instructional Objectives. The accomplished instructor is one who has developed skill in using a great variety of instructional methods. For each course objective, the instructor can select from a variety of methods, one or more of which will lead to effective learning. The instructor who is limited in methods often tries to reach an objective by using inappropriate techniques. The result is a lack of student interest and attention, inefficient learning, or failure to achieve the instructional goals.

Too many instructors use only one or two methods. Many instructors lecture most of the time. Today, with the great variety of interesting and effective ways of helping students learn, the instructor should develop a repertoire of approaches. Then, rather than use the same methods for all lessons, he or she can draw from this repertoire the ones which are most appropriate for a particular situation.

Course Content. The nature of the course content must be considered in selecting an instructional method. The difficulty of the content and the kinds of skills and knowledge required determine to a great extent the methods which are most appropriate.

Student Population. The size of the student group and their educational level, prior training, aptitudes, maturity, and reading and speaking ability must be considered in selecting instructional methods.

Instructor. The number, quality, and competencies of available instructors is an important factor to consider in selecting instructional methods.

Facilities, Equipment, and Instructional Materials. Each instructional method requires the use

of specific types of facilities, equipment, and materials. If the proper facilities are not available, an alternative method may be required.

Time. The time available for a particular block of instruction also governs the method selected. If instructional time is extremely limited, an alternative to the most effective method may be required.

Costs. The costs involved in using a particular method cannot be separated from the other factors. Time, facilities, personnel, and equipment all involve costs. These factors must be taken into account when selecting instructional methods.

THE LECTURE METHOD

A lecture is a semiformal presentation by the instructor of a series of events, facts, concepts, or principles, an exploration of a problem, or an explanation of relationships. Students participate in a lecture mainly as listeners. A lecture is basically a means of telling students information they need to know. This does not mean, however, that all the talking done by the instructor during a class period can be termed a lecture. The term should be reserved to describe a more structured presentation which is used to achieve an instructional objective.

Uses. The purpose of a lecture is to inform. The instructor has information which he or she wishes to transmit to students by means of oral communication. Some of the more appropriate uses of the lecture are:

- to orient students to course policies, rules, procedures, purposes, and learning resources.
- to introduce a subject, indicate its importance, and present an overview of its scope.
- to give directions on procedures for use in subsequent learning activities.
- to present basic material which will provide a common background for subsequent activities.
- to set the stage for demonstration, discussion, or performance.
- to illustrate the application of rules, principles, or concepts.
- to review, clarify, emphasize, or summarize.

Advantages. A properly planned and skillfully delivered lecture is an effective method when used in appropriate situations. Some of the reasons why the lecture is one of the most widely used methods of instruction are that it:

- saves time. The lecture method saves time because the instructor can present more material in a given amount of time than he or she can by any other method.
- permits flexibility of class size. The size of a class is limited only by the size of the classroom to be used or the efficiency of the public address system.
- requires less rigid space requirements. The lecture can be used effectively in any type of training area, indoors or outdoors. The only requirement is that the trainees must be able to hear the lecturer.
- permits adaptability. A skillful lecturer can modify or adjust his or her materials' sequence, vocabulary, and illustrations to meet the needs of a specific group. This makes it possible to present content which is appropriate for the educational level, training, and past experience of the class.
- permits versatility. The lecture can be used for orientation, introduction, review, clarification, and summary. It can be used at any point in a course, and it can be combined easily and effectively with any other method of instruction.
- permits better control over content and sequence. Because the instructor determines what is to be presented and the order of presentation, the desired coverage and sequence can be accomplished with little danger of engaging in time-consuming detours.

Disadvantages. Some of the disadvantages of the lecture method are that it:

- involves one-way communication. The instructor prepares and presents the material. The student sits, listens, and takes notes. Most lectures, therefore, permit little or no interchange of ideas between the instructor and the students. All ideas presented to the class originate with the instructor.

- poses problems in skill teaching. The lecture method is an inappropriate way to teach skills such as equipment operation.

- appeals mainly to one sense. Most learning takes place through the visual sense. The lecture, even if supplemented by training aids, appeals mainly to the auditory sense. Unless the content is interesting and challenging enough to hold the attention of the class, the results are likely to fall short of the instructional goal.

- contributes to student passiveness. During a lecture, students are passive. Their job is to listen. Attention is difficult to attract and retain. Outside disturbances easily and frequently distract the students and make the lecture ineffective.

- poses evaluation problems. If an instructor is to teach rather than merely present information, he or she must be aware of student reactions, misconceptions, inattention, and difficulties, and he or she must remedy them immediately. The lecture method makes these perceptions difficult. Most students have acquired the ability to appear attentive, although they may not even be listening. The lecturer receives very little feedback, and much of what he or she does receive is often misleading.

- depends on the skill of the instructor. In a lecture, student interest and attention must be generated by the instructor. The instructor must plan carefully, display sincerity and enthusiasm, present material in a proper sequence, use appropriate vocabulary, employ effective speaking techniques, be sensitive to the reaction of the students, and modify the presentation on the basis of class response. Failure to do any of these things will result in a loss of student attention and interest, and a failure to achieve the objectives of instruction. The ultimate success of a lecture depends on the skill of the instructor.

THE CONFERENCE METHOD

The conference is a method in which group discussion techniques are used to reach instructional objectives. These discussion techniques include questions, answers, and comments from the instructor in combination with questions, answers, and comments from the students, and are directed toward learning goals. There are three types of conferences: directed discussion, training conferences, and seminars. Clear distinctions do not exist between any of these forms; however, the objectives of the conference, and the kind and amount of student participation, determine when a directed discussion becomes a training conference, and when a training conference becomes a seminar.

The objective of a **directed discussion** is to help students acquire a better understanding of and develop an ability to apply known facts, principles, concepts, policies or procedures. The function of the instructor is to guide the student discussion in such a way that the facts, principles, concepts, or procedures are clearly articulated and applied.

In a **training conference**, the objective is to pool the knowledge and past experience of the students to arrive at improved or more clearly stated principles, concepts, policies or procedures. The topics discussed in a training conference are less likely to have pat answers than those used in a directed discussion. The task of the instructor is to elicit contributions from the group based on their past experiences which have a bearing on the topic at hand.

The purpose of the **seminar** is to find an answer to a question or a solution to a problem. The instructor does not have an answer or a solution; in fact, there is no known best or correct solution. Rather, the instructor is seeking an answer

and encourages the students to develop one. The primary functions of the instructor are to describe the problem as he or she understands it and to encourage free and full participation in a discussion aimed at: identifying the real problem, gathering and analyzing data, formulating and testing hypotheses, determining and evaluating alternative courses of action, arriving at conclusions, or making recommendations to support or arrive at a solution or a decision.

Uses. The conference method is a valuable tool in the instructor's kit. Some of the more important applications of this method are:

- to develop imaginative solutions to problems.
- to stimulate interest and thinking, and to secure student participation in situations which would otherwise allow the class to remain passive.
- to emphasize the main teaching points.
- to supplement lectures, readings or laboratory exercises.
- to determine how well students understand concepts and principles, and to determine if they are ready to proceed to new or more advanced material.
- to prepare students for the application of a theory or procedure to specific situations.
- to summarize, clarify, or review.
- to prepare students for subsequent instruction.
- to determine student progress and the effectiveness of prior instruction.

Advantages. Some of the advantages of the conference method are that it:

- increases student interest. The opportunity to express one's own views and to hear the opinions of others is stimulating. Interest is unusually high in a well-planned and skillfully conducted conference.
- increases student acceptance and commitment. Because students actively participate in developing the lesson, they tend to accept the importance and validity of the content and are more deeply committed to solutions or decisions than they would be if the content were merely presented to them.
- utilizes student knowledge and experience. The conference method enables the instructor to make effective use of the students' backgrounds, previously acquired knowledge, and experiences. The entire class and the instructor benefit from the experience and thinking of all students.
- results in more permanent learning. Learning takes place in direct ratio to the amount of individual participation in the learning process. The conference demands a high degree of student participation, thereby promoting better and more permanent learning.

Disadvantages. Some of the disadvantages of this method are that it:

- requires highly skilled instructors. The conference is more exacting of the resourcefulness, initiative, and ability of the instructor. The instructor must be able to guide the discussion without appearing to do so. He or she must be thoroughly informed on all aspects of the subject under discussion. The instructor must also: keep the discussion on the track, minimize debate over unimportant details, relate comments to topics previously discussed, avoid reopening topics already discussed, encourage and get full participation, prevent domination by a few students, summarize each topic, and bring the discussion to a close.
- requires preparation by students. Most conferences require advance preparation in the form of reading assignments, thinking, and study before the meeting. The thoroughness of the preparation determines the quality of the discussion and the outcome of the conference. Little or no instructor control can be insured over the quality or thoroughness of student preparation. This results in variation among students in their readiness to participate in the conference.

• limits content. The content appropriate for discussion is restricted. Manipulative operations, functions, procedures, or introductory materials do not ordinarily provide suitable content for a conference.

• consumes time. Relatively large blocks of time must be allocated if a discussion is to be profitable. For this reason, the conference is often ruled out as an approach although it may be well suited to the subject and the class.

• restricts size of group. The conference method cannot be used effectively with groups larger than 12 to 15 students, because the opportunity for individual participation is too limited. More reticent members are likely to be left out of the discussion and denied valuable learning experiences.

• requires selective group composition. The members of a conference group, in most cases, must possess the proper background, maturity, and motivation if the discussion is to be profitable. The desired degree of participation is difficult to obtain if the group is composed of one subgroup which has ample experience in the area to be discussed and another subgroup which has extremely limited experience.

THE DEMONSTRATION METHOD

A demonstration is a method of instruction where the instructor, by actually performing an operation or doing a job, shows the student what to do and how to do it, and through explanations brings out why, where, and when it is done. Usually the student is expected to be able to repeat the job or operation after the demonstration. For this reason, the demonstration is often used in conjunction with another method. The most common combinations are the lecture-demonstration and the demonstration-performance.

Uses. The basic purpose of a demonstration is to show how something is done. It should be employed wherever and whenever practicable. Some of its more important applications are:

- to teach manipulative operations or procedures, or how something is done.
- to teach problem-solving and analytical skills.
- to illustrate principles, or why something works.
- to teach the operation or functioning of equipment, or how something works.
- to teach teamwork, or how people work together to do something.
- to set standards of performance.
- to teach safety procedures.

Advantages. Some of the advantages of the demonstration method are that it:

• improves learning. Students learn faster and more permanently with a demonstration. A demonstration makes explanations concrete by giving meaning to words. Relationships between steps of a procedure and the accomplishment of the objective are clarified in a demonstration. Students not only see and hear during a demonstration, they are often given the opportunity to touch the equipment. When well planned and executed, a demonstration has a dramatic quality which arouses and sustains interest and attention.

• minimizes damage and waste. Equipment is often damaged when students attempt to operate it without proper guidance. Much of this damage and waste can be prevented by the use of demonstrations.

• saves time. A properly planned demonstration takes much less student time than other methods. It reduces oral explanation time and at the same time prevents misunderstandings about how a system or a piece of equipment works.

• can be presented to large groups. Class size is limited only by the ability of the group to see the object being demonstrated. The use of large-scale mockups or models makes it possible to teach many operations to large classes.

Disadvantages. Some of the disadvantages of this method are that it:

- requires careful preparation and rehearsal. A demonstration should set a standard of performance for students. The procedure must be technically correct and must be performed with a skill greater than that expected of students. The instructor must be sure that the equipment is in working order. Nothing fails as completely as a demonstration that doesn't work.

- requires special classroom arrangements. The demonstration room must be set up so that all students can clearly see every phase of the demonstration.

- requires equipment and aids. The equipment, often expensive, must be taken out of an operational setting. Therefore, the removal of this equipment must be offset by gains in training. Sometimes, models or mockups must be purchased or constructed. These represent a rather costly investment of time, money, and other resources.

THE PERFORMANCE METHOD

The performance method requires the student to perform, under controlled conditions, the operation, skill, or movement being taught. Performance is learning by doing.

There are four basic types of performance. **Independent practice** requires students to work individually at their own pace. In **group performance** or **controlled practice**, students work together step-by-step at the rate set by the instructor. The **coach and pupil** method involves pairing students. Members of each pair perform alternately as instructor and student. In **team performance**, a group of students perform an operation or function as a team.

Uses. In general, the performance method has the same applications as the demonstration method and is used as follow-on instruction:

- to teach manipulative operations or procedures.

- to teach the operation or functioning of equipment.

- to teach team skills.

- to teach safety procedures.

Advantages. The main advantages of the performance method are that it:

- builds confidence. Given the opportunity to apply their knowledge in a realistic situation, students develop confidence in their ability and a positive attitude toward the learning situation.

- increases learning. Active student participation is maximized. This fact, coupled with the interest and attention generated by putting theory into practice, increases both the amount and the permanence of learning.

- enables learning evaluation. With the performance method the instructor has an opportunity to observe the degree of learning attained by each student, to identify students having difficulty, and to determine if there have been weak areas in the instruction.

- reduces damage and waste. Because performance is guided, students are less likely to make mistakes which will damage equipment or waste materials.

- promotes safety. Guided performance makes it possible to emphasize the proper method of performance and helps prevent accidents.

Disadvantages. Some of the disadvantages of the performance method are that it:

- requires tools and equipment. If a practical exercise is to be conducted, every student must participate fully. Therefore, tools and properly functioning equipment must be available in sufficient quantity for the size of the class.

- requires large blocks of time. A well-run practical exercise is often time-consuming in its requirements for setting up the room and equipment, and in accomplishing the actual setting up of the room and equipment for individual or team performance of the complete operation.

- requires more instructors. Unless the class is very small, a number of qualified instructors are required to keep a constant check on the progress of each student, to give assistance when needed, and to evaluate the quality of the performance.

PROGRAMMED INSTRUCTION METHOD

Programmed instruction is a method of self-instruction in which the student works through a carefully sequenced and pretested series of steps leading to the acquisition of knowledge or skills representing the instructional objectives. The student proceeds through the program at his or her own rate, responds actively to each step in the sequence, and receives immediate feedback on the correctness of his or her response before proceeding to the next step. Programs are usually designed to permit the student to master the desired knowledge or skills.

Uses. The programmed instruction method can be used:

- to provide remedial instruction.

- to provide makeup instruction for late arrivals, absentees, or transients.

- to maintain previously learned skills which are not performed frequently enough to insure an acceptable level of proficiency.

- to provide retraining on equipment and procedures which have become obsolete or have been replaced since the original training was given.

- to upgrade production, administrative, or other types of skills and knowledges.

- to accelerate capable students and thereby enable them to complete a course in less than the usual amount of time.

- to provide a means of insuring enough common background among students to profit from formal classroom work.

- to provide the review and practice of knowledge and skills needed to "set" the learning.

- to provide a source of vertical enrichment (advanced work) or horizontal enrichment (broader contact) in a content area.

- to control the variables in a learning situation for experimental purposes.

Advantages. The advantages of programmed instruction are that it:

- reduces the failure rate. The student failure rate is reduced because programs are tested and validated before they are used. This procedure insures that the program is effective in performing the instructional job. The self-pacing feature of the material also helps, because students are exposed to the material at a rate which is appropriate for each individual. The "forced" response and immediate confirmation features guarantee continuous attention to the material, correct wrong responses, and prevent misinterpretation and the practice of errors.

- improves end-of-course proficiency. The pretesting, self-pacing, forced attention, and immediate feedback features of programs result in better, more efficient, and more permanent learning. Thus, end-of-course proficiency is markedly increased.

- saves time. The rigid control over content made possible by the procedures used for developing, testing, and validating programs prevents the introduction of unnecessary content and thereby reduces the time required to learn the critical material. The self-pacing feature, along with forced attention, decreases the teaching time required, and frequently results in an average time savings of 30 percent or more over conventional instructional methods.

• standardizes instruction. The instructional content and sequence of a program are predetermined. They are not subject to the whims, preferences, experiences, or biases of the instructor. The quality of instruction does not vary from day to day nor from instructor to instructor. There is almost complete control over the content, sequence, and form of student responses. Hence, instruction becomes standardized and can be repeated without change at any time for any individual or group.

• requires no special facilities. Programmed materials can be used anywhere at any time. No specially equipped rooms or facilities are necessary.

• provides for self-instruction. Although under ordinary conditions programs are not used as substitutes for instructors, they can be so used. Programs are validated under conditions where they alone do the teaching. Therefore, they are effective instructional materials even if no qualified instructor is available.

• accommodates student differences. Programs can be designed to accommodate wide differences in aptitude, ability, speed of learning, prior training, and experience. The needs of students, whether for more or less exposure, detail, or practice, can be met. The size of a class is also unimportant. Programs can be used to achieve group or individual progress.

• improves efficiency and economy for group or individual instruction. The self-pacing feature and the handling of large or small groups make for greater efficiency and economy. In addition, programs free instructors from routine, repetitive teaching tasks and enable them to spend a larger part of their time on more difficult or more demanding aspects of instruction.

Disadvantages. The disadvantages of the programmed instruction method are that it:

• requires local or commercial preparation. Although the number of available programs is growing rapidly, those which may be used locally are limited. Most programs produced by commercial publishers or other sources do not match the instructional objectives of local courses. For this reason, programs must be developed locally or contracted with commercial programming companies.

• requires lengthy programmer training. Very few trained programmers are available locally. The training program is relatively lengthy and demanding. Only a small percentage of persons exposed to programmer training will become competent programmers.

• increases expenses. Programs, whether developed locally or contracted, are extremely costly. For local development there must be a large investment in programmer training and an even larger one in program writing, testing, and validation. Program development by contract is expensive, and the time required by subject-matter experts and technicians for consulting with programmers and reviewing draft materials is considerable.

• requires considerable lead time. Programmed materials cannot be selected or developed quickly. Lead time is required to screen and select appropriate programs from those available. If programs are developed by school staff or contract programmers, the lead time for production, testing, and validation is even greater. If the course content is unstable or subject to frequent and radical change, it is inappropriate for programming.

• demands competent instructors. Instructors must be able to motivate students to complete programs. They must be able to assist any student at any point in the programmed sequence. If instructors are to be able to provide the motivation, guidance, and assistance required for the optimum use of programmed materials, they must have: insight into the learning process; a thorough understanding of the rationale, principles, construction, and use of programming; skill in conducting tutorial-type instruction and individual counseling; and a mastery of the subject matter of the programs used.

• requires mature students. The use of programs requires a student group which is mature enough and sufficiently well motivated to work independently. Also, they must be able to read at the level required for full understanding of the program.

• poses administrative problems. The use of programmed materials creates unique administrative problems. Foremost among these are the scheduling and assignment problems caused by the self-pacing feature of programs. This feature results in different phase and course completion times with consequent difficulties in scheduling following instruction and assigning graduates to field units.

THE STUDY ASSIGNMENT METHOD

The study assignment is a method in which the instructor assigns readings in books, periodicals, manuals, or handouts; requires the completion of a project or research paper; or assigns problems and exercises for the practice of a skill. This method involves imposing a task, providing for student motivation, and giving general directions for carrying out the assignment. Implicit in this method are the problems of setting up worthwhile learning activities and anticipating student difficulties and means of overcoming them. If these steps are not well handled, the objectives of the assignment are not likely to be achieved.

The study assignment has two basic forms. In an **independent study** the student carries out the assignment without instructor assistance or direct guidance. In a **supervised study** the student carries out the assignment with an instructor available for guidance and assistance.

Uses. The study assignment method can be used:

• to orient students to a topic prior to classroom or laboratory work.

• to set the stage for a lecture, demonstration, or discussion.

• to provide for or capitalize on individual differences in ability, background, or experience through differentiated assignments.

• to provide for the review of material covered in class or to give the practice essential for the development of skills and problem-solving ability.

• to provide enrichment material.

Advantages. Some of the advantages of the study assignment method are that it:

• increases coverage of material. A far greater amount of material, and detailed treatment of it, can be covered in a shorter period of time by study assignments than by any other means.

• reduces classroom time. Used properly, study assignments can serve as a substitute for lectures; study assignments can make lectures, demonstrations, and conferences more meaningful and more productive.

• improves learning. Practice is essential to the development of skills. Study assignments provide a means of giving enough practice to insure mastery of the skill.

• permits individualized attention. Study assignments can be designed to make use of the experience, special skills, or interests of students, or to remedy individual deficiencies in skill or knowledge.

• reduces instructor interpretation. Students may be referred to the original source instead of being exposed only to the instructor's interpretation. This insures that the content will be presented as intended by the originator of the material.

Disadvantages. Some of the disadvantages of this method are that it:

• requires careful planning and follow-up. If students are not well motivated, they are not likely to do a thorough job with assignments, especially those which they must do on their

own. The instructor must plan and assign work in such a way that the objectives and instructions are clear and the motivation is present. The instructor also must follow up to insure that the assignment has been carried out.

- poses evaluation problems. The effectiveness of study assignments is difficult for an instructor to evaluate. It is also difficult for him or her to determine what went wrong with a study assignment when the results are not as good as anticipated.

- results in the practice of errors. In skill development it is critical that the skill be practiced in the prescribed mode. Particularly with independent practice, there is a danger that the student will practice an incorrect procedure or error. When this occurs, a large expenditure of time is required to "unlearn" the skill and "relearn" it correctly.

- produces nonstandard results. The variations in reading ability and differences in motivation in any group produce varying degrees of learning when study assignments are used. Where standardization of learning is essential, study assignments may be inappropriate.

THE TUTORING METHOD

Tutoring is a method of instruction in which an instructor works directly with an individual student. The method may involve exposition, demonstration, questioning, coaching, or guided practice.

Uses. Tutoring can be used:

- to teach highly complex skills and operations, or operations which involve potential danger to students or hazards to expensive equipment.

- to provide individualized remedial assistance.

Advantages. Some of the advantages of tutoring are that it:

- permits adaptive instruction. Tutoring provides the optimum in individualized instruction. The needs of the individual student can be diagnosed and instruction can be tailored to meet his or her unique needs.

- stimulates active participation. In a tutorial setting, the highest possible degree of student participation can be achieved. Direct involvement in the learning, by answering and asking questions, by performing under supervision, is guaranteed.

- promotes effective learning. The ability of the tutor to adapt instruction to the needs of the individual, together with the high degree of interaction and participation of the student, make this method extremely effective in achieving instructional objectives.

- promotes safety. The one-to-one instructor-student ratio provides close control over performance of hazardous operations, resulting in the prevention of injury to the operator or damage to the equipment.

Disadvantages. Some of the disadvantages of this method are that it:

- requires highly competent instructors. Tutoring is one of the most demanding types of instruction to conduct. It requires complete mastery of the content and skill in diagnosing and remedying learning difficulties.

- demands time and money. Tutoring is probably the most expensive method of teaching. Although only one student is receiving instruction, instructor preparation and presentation time are essentially the same as they would be for a whole class of students.

THE COMBINATION METHOD

This is a method of instruction which uses two or more basic instructional methods in combination. For example, one lesson might include a study assignment, a lecture in which safety precautions in handling a piece of equipment are

emphasized, a demonstration by the instructor, and, finally, performance by the students.

Uses. Combination lessons can be used to meet almost any type of instructional objective in any training situation. However, they are most appropriate where skill development is involved.

Advantages. The advantages of using a combination of methods are that they:

- increase interest. The variety of methods used in a combination lesson make for a more interesting and engaging instructional period.

- promote flexibility. The use of several methods frees the instructor from the restricting or limiting aspects of any single method. He or she can easily adjust the lesson to the needs of the class and the requirements of the situation.

- improve learning. The combination lesson maximizes the advantages of any single method. It allows the instructor to use approaches which complement each other. This fact, plus the advantage of higher student interest, results in improved learning.

Disadvantages. The disadvantages of using a combination of methods are that they:

- require highly skilled instructors. Instructors must be able to use all methods of instruction with a high degree of skill.

- require smaller groups. The use of methods in combination requires closer control by the instructor and better supervision of student activities. To obtain the desired control, classes must be kept small.

SECTION 1.7

Teaching-Learning Resources for the Instructor

Section 1.7 provides the instructor with a variety of instructional resources and references for use in building maintenance curriculum development efforts. Listed here are audio-visual resources, texts and reference materials, sources of career opportunities and educational development information, and sources of additional information and assistance. For many of the references and resources listed in this section, a complete catalog of their available materials can be obtained from them upon request.

Advance Floor Machine Company, P.O. Box 275, Spring Park, Minnesota 55384

Texts and References

Team Mates

Floor Maintenance Machines

The Operation of the Carpetron

Daily Work Planning Guide

Arco Publishing Company, 219 Park Avenue South, New York, New York 10003

Texts and References

Janitor–Custodian

Maintenance Man

Stationary Engineer

Fireman

Armstrong Cork Company, Liberty and Charlotte Streets, Lancaster, Pennsylvania 17604

Texts and References

Commercial Maintenance System Guide

Samples of Resilient Tiles

Commercial Maintenance and Operation

The Fog and Buff Method

Economics Laboratories, Inc., Osborn Building, St. Paul, Minnesota 55102

Texts and References

Soilax

Micro-Bac: Environmental Sanitation

Mikroklene: Environmental Sanitation

S. C. Johnson and Son, Inc., 1525 Howe Street, Racine, Wisconsin 53403

Films and Filmstrips

Permacare System

Gym Floor Care

The Finishing Touch

Better Washroom Maintenance

An Ounce of Prevention

Texts and References

Building Maintenance Manual

Modern Building Maintenance Handbook

Twelve Steps to Cutting Building Maintenance Costs

Technique for Hospital Room Disinfection

National Sanitary Supply Association, 5330 North Elston Avenue, Chicago, Illinois 60630

Films and Filmstrips

Cleaning and Maintenance of Soft Floors

Resilient Floor Care

Brush Up on Brushes

Washroom Care and Care of Washroom Fixtures

How to Achieve Cleanliness at Lower Cost

Texts and References

Modern Cleaning Methods

Maintenance Planning Workbooks

Norwood Films, 926 New Jersey Avenue NW, Washington, D.C. 20001

Films and Filmstrips

Interior and Exterior Trim (Carpentry)

Waxey: Tips on the Fine Art of Waxing

Moppy: New Methods for Easier Mopping

Sanding Flat and Irregular Surfaces

Principles of Refrigeration

Pressure Gauges

Cutting and Threading Pipe by Hand

Cutting and Threading Pipe on a Power Machine

Care of a Tractor

An Introduction to Hand Tools

Repainting a Frame Building

Public Works and Public Utilities

How to Apply Paint by Roller, Brush, and Spray

How to Store Paint

Ohio State University, Motion Picture Division, Townsend Hall, Room 113, 1885 Neil Avenue, Columbus, Ohio 43210

Films and Filmstrips

What Happened to Harry? (plumbing dangers)

Custodial Training

Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402

Texts and References

School Building Maintenance Procedures

School Plant Management

Administering the Custodial Program

Paint Manual

Building Maintenance and Sanitation Services (free)

Maintenance Man, Building: A Suggested Guide for a Training Course ($0.35, GPO No. 1780-0463)

Maintenance and Safety (Mechanical and Physical Hazards Series) ($0.20, GPO No. 2903-0019)

Safe Use of Hand and Portable Power Tools ($0.35, GPO No. 2903-0043)

Simple Plumbing Repairs for the Home and Farmstead ($0.10, GPO No. 0100-1033)

Builder 3 and 2 Training Manual ($4.25, GPO No. 0847-0136)

Building Custodian: A Suggested Guide for a Training Course ($0.35, GPO No. 1780-0458)

Machinist's Mate 3 and 2 Training Manual ($2.50, GPO No. 0847-0080)

Machinist's Mate 1 and C Training Manual ($2.25, GPO No. 0847-0079)

Plumbing for the Home and Farmstead ($0.15, GPO No. 0100-1316)

Concrete Manual ($4.75, GPO No. 2403-0023)

Paintings and Protective Coatings ($7.25, GPO No. 0820-0113)

State University of Iowa, Bureau of Audio-Visual Instruction, Extension Division, Iowa City, Iowa 52240

Films and Filmstrips

A Mowing Lesson for Charlie

Loop and Circuit Venting: The Plumbing System

University of Illinois, Vocational Agricultural Service, 434 Mumford Hall, Urbana, Illinois 61801

Films and Filmstrips

Concrete Masonry

Identification of Pipe and Fittings

Care, Operation and Adjustment of Mowers

OTHER FILMS, FILMSTRIPS, TEXTS AND REFERENCES

ABC of Hand Tools (film), General Motors Corporation, Saginaw Steering Gear Division, c/o Supervisor of Work Standards, 3900 Holland Road, Saginaw, Michigan 48601

Bigelow Carpets Go to School, Bigelow-Sanford Inc., P.O. Box 3089, Greenville, South Carolina 29602

Bricklayer and Stonemason (film), Stanley Bowmar Company, 12 Cleveland Street, Valhalla, New York 10595

Complete Guide to Building and Plant Maintenance, Prentice-Hall, Inc., Englewood Cliffs, New Jersey 07632

Concrete (film), University of California, Educational Films Sales Department, Berkeley, California 94720

Cutting Costs with Carpet, Carpet and Rug Institute, P.O. Box 2048, Dalton, Georgia 30720

Floor Cleaning Equipment Catalog (No. 67), Geerpres Wringer Company, 1780 Harvey Street, Muskegon, Michigan 49443

Fundamentals of Carpentry, American Technical Society, Chicago, Illinois

Handbook for School Custodians (No. 137), University of Nebraska, Extension Division, Lincoln, Nebraska 68508

Heating, Ventilating, and Air Conditioning Guide, American Society of Heating, Refrigerating, and Air Conditioning Engineers, United Engineering Center, 345 East 47th Street, New York, New York 10017

Here's How (filmstrip), National Paint, Varnish, and Lacquer Association, 2835 East Washington Boulevard, Los Angeles, California 90023

Landscape Appreciation (film), National Instructional Television Library, 10 Columbus Circle, New York, New York 10019

Operating and Maintenance Instructor, Briggs and Stratton Corporation, P.O. Box 702, Milwaukee, Wisconsin 53201

Parker Vac-35, Parker Sweeper Company, 91 Bechtle Avenue, Springfield, Ohio 45504

Power Tools for You (film), Association Films, 347 Madison Avenue, New York, New York 10017

Professional Application with Best (filmstrip), Best Maintenance Supply Company, 1922 East Seventh Place, Los Angeles, California 90021

Scott Washroom Advisory Service, Scott Paper Company, Scott Plaza, Philadelphia, Pennsylvania 19113

Sealers for Wood and Concrete, Masury Paint Company, 1401 Severn Street, Baltimore, Maryland 21230

The Story of Acrylic Paint (film), Rohm and Haas Company, Independence Mall, Philadelphia, Pennsylvania 19105

SOURCES OF CAREER OPPORTUNITIES, INFORMATION, AND ASSISTANCE

Air-Conditioning and Refrigeration Institute, 1815 North Fort Myer Drive, Arlington, Virginia 22209

American Association for Vocational Instructional Materials, Engineering Center, Athens, Georgia 30601

American Industrial Arts Association, 1201 Sixteenth Street, NW, Washington, D.C. 20036

American Institute of Constructors, 1140 NW 63rd Street, Suite 511, Oklahoma City, Oklahoma 73116

American Institute of Maintenance, 710 West Wilson Avenue, Glendale, California 91209

American Institute of Steel Construction, 1221 Avenue of the Americas, New York, New York 10020

American Society of Plumbing Engineers, 16161 Ventura Boulevard, Encino, California 91436

American Technical Education Association, North Dakota State School of Science, Wahpeton, North Dakota 58075

American Vocational Association, Inc., 1510 H Street, NW, Washington, D.C. 20005

American Welding Society, 2501 NW Seventh Street, Miami, Florida 33125

Bricklayers, Masons and Plasterers' International Union of America, 815 Fifteenth Street, NW, Washington, D.C. 20005

Building and Construction Trades Department, AFL-CIO, 815 Sixteenth Street, NW, Washington, D.C. 20006

Building Officials and Code Administrators International, 1313 East 60th Street, Chicago, Illinois 60637

Construction Specification Institute, 1150 Seventeenth Street, NW, Washington, D.C. 20036

General Building Contractors Association, 2 Penn Center Plaza, Suite 1212, Philadelphia, Pennsylvania 19102

Industrial Education Institute, 221 Columbus Avenue, Pittsburgh, Pennsylvania 15232

International Brotherhood of Painters and Allied Trades, U.N. Building, 1750 New York Avenue, NW, Washington, D.C. 20006

Mechanics Educational Society of America, 1421 First National Building, Detroit, Michigan 48226

National Association of Industrial and Technical Teacher Educators, Kearney State College, Kearney, Nebraska 68847

National Association of Plumbing-Heating-Cooling Contractors, 1016 Twentieth Street, NW, Washington, D.C. 20036

National Association of State Directors of Vocational Education, 2805 Eisenhower Street, Eau Claire, Wisconsin 54701

National Association of State Supervisors of Trade and Industrial Education, 1510 H Street, NW, Washington, D.C. 20005

National Association of Women in Construction, 2800 West Lancaster, Fort Worth, Texas 76107

National Concrete Masonry Association, 6845 Elm Street, P.O. Box 135, McLean, Virginia 22101

National Employment Counselors Association, 1607 New Hampshire Avenue, NW, Washington, D.C. 20009

National Vocational Guidance Association, 1607 New Hampshire Avenue, NW, Washington, D.C. 20009

Operative Plasterers' and Cement Masons' International Association of the U.S. and Canada, 1125 Seventeenth Street, NW, Washington, D.C. 20036

Sheet Metal and Air Conditioning Contractors' National Association, 1611 North Kent Street, Suite 200, Arlington, Virginia 22209

Sheet Metal Workers' International Association, AFL-CIO-CLC, 1750 New York Avenue, NW, Washington, D.C. 20006

United Association of Journeymen and Apprentices of the Plumbing and Pipe Fitting Industry of the U.S. and Canada, 901 Massachusetts Avenue, NW, Washington, D.C. 20001

United Brotherhood of Carpenters and Joiners of America, 101 Constitution Avenue, NW, Washington, D.C. 20001

Vocational Industrial Clubs of America, 105 North Virginia Avenue, Falls Church, Virginia 22046

PART TWO

GUIDE FOR STUDENT SELECTION
AND
PLACEMENT IN THE TRAINING PROGRAM

SECTION 2.1
How to Use Part Two of the Guide

Part Two of the guide offers the school guidance counselor career information and recommends a set of steps that can be used to determine criteria for student selection and placement in the training program. The guidance counselor should become familiar with the sections presented in Part Two so that effective guidance activities, corresponding to the intent of the curriculum, can be carried out. In addition, Sections 1.2 and 1.3 of Part One are essential to the guidance process and should be reviewed by the guidance counselor.

STEP 1: Review how the guide was developed. Read Section 1.2, "How the Guide Was Developed," to gain a thorough understanding of the structure and development of the guide and to become familiar with these key concepts and terms: occupational analysis, career ladder, worker trait group, task statement, and task inventory.

STEP 2: Review the information on the career field. Read Section 1.3, "General Job Description: Maintenance Worker," for a comprehensive overview of the career field, descriptions of the type of work performed, employment forecasts, and other important career information.

STEP 3: Know the use and function of the Dictionary of Occupational Titles. If you have not already done so, you should become familiar with the use and function of the Dictionary of Occupational Titles and its supplements, which are available from the U.S. Department of Labor. These documents are the foundation upon which the industrial maintenance training program and guidance activities are built.

STEP 4: Study the qualifications profile. Section 2.3, "Qualifications Profile for the Entry-Level Maintenance Helper," presents a composite profile of the entry-level worker and is based on the principal worker trait groups associated with maintenance from the Dictionary of Occupational Titles. This profile can be used in preliminary screening activities and in counseling students who want to enter the training program. Section 2.5, "Worker Trait Codification System," explains in full the knowledge, aptitude, and interest levels associated with these worker traits.

STEP 5: Determine the General Educational Development (GED) level of students. One part of the qualifications profile is a suggested level of competence related to general educational development. Section 2.2, "Career Guidance for Building Maintenance," includes a description of the General Aptitude Test Battery (GATB) which can be used to determine the GED level of students as well as their aptitudes and interests.

STEP 6: Use the Advanced General Education Program for GED remediation. Section 2.4 provides a description and list of instructional units contained in the Advanced General Education Program. All or parts of this program can be used for remediation purposes based on the administration of the GATB.

STEP 7: Provide guidance for students who leave the program or who do not qualify. The results of the GATB, when used in conjunction with the qualifications profile, provide a useful starting point for counseling students who drop out of the program or whose interests, aptitudes, and GED level do not seem appropriate for the career field.

STEP 8: Coordinate your guidance activities with the instructor. Review the sections in Part One of the guide to gain an understanding of how the curriculum and instructional development activities correspond to the recommended guidance activities. Discuss student selection and placement activities with the instructor in order to better coordinate your efforts.

SECTION 2.2
Career Guidance for Building Maintenance Occupations

Part Two of this guide is based on an extensive pool of career and job information maintained by the U.S. Employment Service and the Department of Labor. This and associated information is widely used by federal, state, and local governments, industry, private agencies, companies and institutions in hiring and placing workers and in defining worker duties, tasks, and activities.

By using Part Two in conjunction with the General Job Description (Section 1.3) and the Inventory of Job Tasks and Learning Objectives (Section 1.4), the guidance counselor will be able to:

- provide students with useful career decision making information based on their interests, aptitudes, and previous educational experience.
- determine the General Educational Development (GED) level of individual students as it relates to the maintenance field.
- determine the prerequisite learning needs of a student prior to his or her placement in the training program.

The guidance materials are a response to the many social factors which converge to stimulate interest in the career development needs of young people. All of these factors have in common the search for a set of values which will give meaning and usefulness to students' lives. Among the most important of these social factors are:

- the growing complexity in the occupational and organizational structure of society which makes it difficult for a person to assimilate and organize the data necessary to choose a career.
- the increasingly rapid rate of technological change which demands human adaptability and responsiveness.
- the increasing national concern for developing all human talent regardless of sex, age, religion, or ethnic origin.
- the need for specialized training to obtain entry-level jobs.
- the apparent disenchantment expressed by students who have difficulty relating their education to their lives.

The evolving view of a job is that it should be considered as one step in an integrated, life-long career. A job is a step on a career lattice involving both horizontal and vertical dimensions: horizontally, it involves a pattern of choices at one point in time; vertically, it involves choices over a period of time.

Career guidance should not be viewed as a static, tradition-based set of services that assists students in making simple occupational choices. Guidance must be developed from an initial assessment of the present and future career needs of students and must account for changes in the career field that could affect the development and fulfillment of students' expectations. The content of a guidance program can be organized in many ways to facilitate the student's development. Whatever its form, however, the program ultimately should encourage a student to assume responsibility for his or her own career development.

A career guidance program based on the counselor's experience, expertise, and use of the information presented here will help the student assimilate and integrate knowledge, experience, and appreciation related to the following career development efforts:

- self-understanding, which includes a person's relationships to his or her own characteristics and perceptions, to others, and to the society.

- an understanding of the world of work and those factors that affect its constant changing, including worker attitudes and disciplines.

- an understanding of the many factors to be considered in career planning.

- an understanding of the information and skills necessary to achieve self-fulfillment in work and leisure.

Section 2.2 is intended to facilitate the process of placing students in the training program. It provides techniques for determining the General Educational Development (GED) level of an individual and relating it to the GED level required for the job. Also presented is a description of the General Aptitude Test Battery, which can be used to determine students' aptitude and interest levels.

DEFINITION OF GENERAL EDUCATIONAL DEVELOPMENT*

General Educational Development (GED) can be defined as education of a general academic nature, ordinarily obtained in elementary school, high school, or college, which does not have a recognized, fairly specific occupational objective; this type of education also may be derived from experience or self-directed study. GED is composed of three types of development: reasoning, mathematical, and language.

Reasoning development involves the capacity to comprehend concepts and systems, solve problems, exercise judgment, and understand and carry out instructions, as well as to adapt to social and work environments.

Mathematical development is the acquisition of basic mathematical skills, not specifically vocationally oriented, such as solving arithmetic, algebraic, and geometric problems.

Language development includes the acquisition of language skills, not specifically vocationally oriented, such as mastery of an extensive vocabulary; use of correct sentence structure, punctuation, and spelling; and an appreciation of literature.

Mathematical and language development are "tool languages" which, although not specifically vocationally oriented, involve basic preparation for specific vocational goals. The descriptions of the various levels of language and mathematical development (see Section 2.5) are based on the curricula being taught at specified grade levels in schools throughout the country. An analysis of mathematics courses in the school curricula revealed distinct levels of progression in the primary and secondary grades and in college. These levels of progression facilitated the selection and assignment of six levels of GED for the mathematical development scale.

Though language courses follow a similar pattern of progression through completion of high school, consisting primarily of learning and applying the principles of grammar, this pattern breaks down at the college level. The diversity of fields of study at the college level precluded establishment of distinct levels of language development for these four years. Consequently, both GED Level 5 and Level 6 are defined by one language curriculum.

USING THE GED LEVELS FOR STUDENT PLACEMENT

In matching the student to the occupational program, it is essential to obtain all occupationally significant information about the student. Appraisal of the student in terms of his or her GED is based on such data as:

- school achievement, including grade level attained, subjects studied, standing in class, and honors or special recognition in specific subjects.

- special courses, either military or civilian.

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* Excerpted from "Relating General Educational Development to Career Planning," U.S. Dept. of Labor, Manpower Administration.

- results of tests which measure the degree of academic achievement or general intelligence.

- vocational and personal achievements in any previous work situations.

- general demeanor and ability to communicate.

These data can be related to an appropriate academic level on the GED chart in Section 2.5. For example, a student who has completed the eighth grade in school and achieved a B average in arithmetic, with C's and B's in other subjects, appears to be at an academic level which relates to GED Level 3.

If more information is needed to make a final determination, the guidance counselor can probe into the courses studied by the student to insure that the school curriculum meets the standards reflected in the curriculum for Level 3 on the GED chart. It should be remembered that a student sometimes has a higher educational development than his or her formal education presupposes, and in such a case he or she should be identified at a higher, more appropriate level.

The primary purpose of determining the GED level of a student is to provide a criterion for use with other information in relating him or her to suitable vocational goals, whether through immediate employment or through additional education and training. All information about the student—the evaluation of his or her aptitudes, interests, and personality characteristics, GED level, and any test results—can be related to areas of work, groups of jobs, and specific jobs in the Worker Traits Arrangement of the Dictionary of Occupational Titles. The most important information relating to building maintenance occupations and worker trait groups is presented in Section 2.3. (A more detailed description of the worker trait codification system appears in Section 2.5.)

The qualifications profile in Section 2.3 includes the GED reasoning, mathematical, and language development levels required for entry-level maintenance workers. These GED levels indicate the degree of educational development, formal or otherwise, which the worker should possess for average satisfactory job performance. By relating the GED level of the student to that required for the maintenance worker, the guidance counselor can do a better job of helping students select vocational goals.

The subject matter areas listed in the GED chart in Section 2.5 can be used in planning basic or supplementary general education for students in the training program or advising a student on the educational basis required for functioning in this career field.

The GED levels listed in the qualifications profile in Section 2.3 constitute the prerequisites for effective job performance at the entry level. Should the prerequisite GED be missing in a candidate for building maintenance training, then the student should be directed to a more appropriate program of occupational training.

If the student is selected for the training program on the basis of other criteria, then steps must be taken to provide him or her with academic training that will raise his or her GED to the desired level. Otherwise, the student will be handicapped in his or her ability to handle the course content of the training program and to perform the required duties and tasks while on the job.

A student who is deficient in prerequisite GED should be encouraged to participate in the Advanced General Education Program (see Section 2.4) either before becoming involved in training or during the building maintenance training program.

GENERAL APTITUDE TEST BATTERY

Another useful tool in placing students in the building maintenance occupations training program is the General Aptitude Test Battery (GATB). The GATB was developed in conjunction with the occupational counseling services of the U.S. Employment Service. According to its developers, the GATB "is designed to measure several aptitudes which have been found important to success in many occupations." The

battery is used primarily as an aid in the more effective placement of applicants who have insufficient job experience. Various state agencies, in cooperation with local school authorities, have been extending the application of the battery to the counseling of high school students.

The battery consists of 15 tests: 11 paper-and-pencil and four apparatus tests. It requires approximately 2½ hours for completion. The tests are designed to measure nine basic aptitudes for 20 fields of work including approximately 2,000 of the occupations classified in the Dictionary of Occupational Titles (D.O.T.). The nine aptitudes are: Intelligence (G), Numerical (N), Verbal (V), Spatial (S), Form Perception (P), Clerical Perception (Q), Motor Speed (T), Finger Dexterity (F), and Manual Dexterity (M).

The qualifications profile presented in Section 2.3 of this guide is derived from the D.O.T. and relates directly to the aptitudes measured in the GATB. For more information on obtaining, administering, and interpreting the results of the General Aptitude Test Battery, contact the local office of the Illinois State Employment Office.

SECTION 2.3
Qualifications Profile for the Entry-level Maintenance Worker

The qualifications profile contained in this section of the guide is based on an analysis of the essential worker traits for the entry-level maintenance worker. The analysis utilized the Dictionary of Occupational Titles and was supplemented by the Handbook for Analyzing Jobs and the Handbook on Relating General Educational Development to Career Planning. All three documents are publications of the U.S. Department of Labor.

Worker traits are defined as the abilities, personal traits, and individual characteristics necessary for a worker to achieve average successful job performance. The qualifications profile provides the broadest and most comprehensive framework for the effective presentation of worker trait information in the career field.

This profile, and the task and objective inventory developed around it (see Section 1.4), are seen as a natural basis upon which to select students for training and provide career counseling. Within this framework, the guidance counselor will find a qualifications profile which indicates:

- the amount of general educational development and specific vocational preparation a worker must have.
- the specific capacities and abilities required of the worker in order to learn or perform certain tasks or duties.
- preferences for certain types of work activities or experiences considered necessary for job success.
- types of occupational situations to which an individual must adjust.
- physical activities required in work situations.
- physical surroundings prevalent in jobs.

All of this information can be used for placing students in or orienting them to the training program, when used in conjunction with the General Job Description (Section 1.3) and the Inventory of Job Tasks and Learning Objectives (Section 1.4).

QUALIFICATIONS PROFILE

The qualifications listed for successful performance as an entry-level maintenance worker are minimally acceptable standards of accomplishment necessary at that level.* (Section 2.5, "Worker Trait Codification System," presents a complete explanation of the levels and codification system used.)

The qualifications listed do not relate to performance requirements existing at higher levels within the career field. In order to progress within the field, the student must have the ability to attain higher-level capabilities through a combination of training and work experience so as to progress up the career ladder.

General Educational Development (GED) Requirements

Reasoning Development, Level 3:	Applies common-sense understanding to carry out instructions furnished in written, oral, or diagrammatic form. Deals with problems involving several concrete variables in or from standardized situations.
Mathematical Development, Level 3:	Make arithmetic calculations involving fractions, decimals, and percentages.
Language Development, Level 3:	**Reading.** Read a variety of novels, magazines, atlases, and encyclopedias. Read safety rules and instructions. **Writing.** Write reports and essays with proper format, punctuation, spelling, and grammar, using all parts of speech. **Speaking.** Speak before an audience with poise, voice control, and confidence, using correct English and a well-modulated voice.

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* It was necessary at times to update and/or modify the Department of Labor information in order to reflect new employment conditions and the realities of training. However, the basic organization and intent of the system developed by the Department of Labor and reflected in the Dictionary of Occupational Titles has been carefully followed. Critical commentary dealing with the development and utilization of the D.O.T. documents points to certain unavoidable limitations, as well as to strengths. An intent to avoid the former and take advantage of the latter underlies the development of the guide and accounts for the modifications of this information.

Specific Vocational Preparation (SVP) Requirements

Level 6: Possesses training over one year up to and including two years so as to perform assigned duties in the organization, to gain knowledge and experience for promotion to next level positions. Observes techniques utilized by experienced workers, learns line and staff functions of each department, and becomes familiar with management policies and viewpoints as they affect each phase of operations.

Aptitude (APT) Requirements

Intelligence (G), Level 4 Capability:	General learning ability. The ability to "catch on" or understand instructions and underlying principles. Ability to reason and make judgments. Closely related to doing well in school.
Spatial (S), Level 4 Capability:	Ability to comprehend forms in space and understand relationships of plane and solid objects. May be used in such tasks as blueprint reading and in solving geometry problems. Frequently described as the ability to "visualize" objects of two or three dimensions, or to think visually of geometric forms.
Form Perception (P), Level 4 Capability:	Ability to perceive pertinent detail in objects or in pictorial or graphic material; to make visual comparisons and discriminations and see slight differences in shapes and shadings of figures and widths and lengths of lines.
Motor Coordination (K), Level 3 Capability:	Ability to coordinate eyes and hands or fingers rapidly and accurately in making precise movements with speed. Ability to make a movement response accurately and quickly.
Finger Dexterity (F), Level 3 Capability:	Ability to move the fingers and manipulate small objects with the fingers rapidly or accurately.
Manual Dexterity (M), Level 3 Capability:	Ability to move the hands easily and skillfully. Ability to work with the hands in placing and turning motions.
Eye-Hand-Foot Coordination (E), Level 3 Capability:	Ability to move the hand and foot coordinately with each other in accordance with visual stimuli.

Interest (INT) Requirements

Factor 1: Situations involving activities dealing with things and objects.	is preferred over	**Factor 6:** Situations involving activities concerned with people and the communication of ideas.
Factor 3: Situations involving activities of a routine, concrete, organized nature.	is preferred over	**Factor 8:** Situations involving activities of an abstract and creative nature.
Factor 9: Situations involving activities that are non-social in nature, and are carried on in relation to processes, machines, and techniques.	is preferred over	**Factor 4:** Situations involving working with people for their presumed good, as in the social welfare sense, or dealing with people and language in social situations.
Factor 0: Situations involving activities resulting in tangible, productive satisfaction.	is preferred over	**Factor 5:** Situations involving activities resulting in prestige or the esteem of others.

Temperaments (TEMP) Requirements

Situation Type 1:	Situations involving a variety of duties often characterized by frequent change.
Situation Type 0:	Situations involving the evaluation (arriving at generalizations, judgments, or decisions) of information against measurable or verifiable criteria.
Situation Type Y:	Situations involving the precise attainment of set limits, tolerances, or standards.

Physical Demands

Heavy work involving the lifting of 100 lbs. maximum with frequent lifting and/or carrying of objects weighing up to 50 lbs., associated primarily with:

Factor 3:	Stooping, Kneeling, Crouching, and/or Crawling
Factor 4:	Reaching, Handling, Fingering, and/or Feeling
Factor 6:	Seeing

Working Conditions

Work is performed both inside and outside under these possible conditions:

Condition 5: Noise and Vibration

Condition 7: Fumes, Odors, Toxic Conditions, Dust, and Poor Ventilation

SECTION 2.4
The Advanced General Education Program

The Advanced General Education Program is designed to teach an individual the information, concepts, and general knowledge required to pass the American Council on Education's High School General Education Development (GED) Test. All students who enter a training program with, or who subsequently attain, qualifying scores on the Advanced Stanford Achievement Test should be encouraged to enter and complete this program if they do not have the prerequisite GED level required for effective performance in the training program. See Section 2.2 for information on determining the GED (General Educational Development) level of students.

The Advanced General Education Program provides comprehensive self-instruction in each of the following areas: correctness and effectiveness of expression, interpretation of literary materials, social studies, natural sciences, and general mathematics.

It should be stressed that the program is very comprehensive and will meet the learning needs of the vast majority of students who qualify for participation (those who have a sixth-grade mathematics and a sixth-grade reading ability as a minimum).

The program has been designed to require little routine teacher attention. Instructions for placement of materials are included in a teacher's manual along with detailed administrative directions. Once students have become familiar with this placement and with the procedures for taking the lessons and grading their own mastery tests, instructor assistance should be required only when students encounter difficulties they cannot themselves resolve and when progress is to be recorded.

The curriculum of the Advanced General Education Program is designed to provide the student with an educational background equivalent to that obtained in the typical high school course of studies, on which the standard high school achievement tests are based.

Emphasis in training is placed on learning concepts, rather than on the test-taking skills which are taught incidentally. The program prepares the student by improving his or her reading ability, increasing vocabulary, providing experience at interpretive tasks, and making him or her broadly familiar with the subject areas covered by the curriculum.

Flexible administration of the program has been accomplished in two primary ways: (1) lesson units do not take more than an hour to complete and (2) periodic screening tests enable the student to either by-pass material he or she may already know or to repeat materials that he or she did not learn sufficiently well. The time required to complete all of the lesson materials in the Advanced General Education Program averages 145 hours with a range of 90 to 230 hours.

Below is a complete listing of program materials in the Advanced General Education Program, which can be ordered from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

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* This section has been excerpted from "Advanced General Education Development—A High School Self-Study Program," U.S. Dept. of Labor, Manpower Administration, Job Corps.

TEACHER'S ADMINISTRATIVE MATERIALS

Teacher's Manual
Teacher's Answer Key
Progress Flow Chart

STUDENTS' INTRODUCTORY AND SELF-ADMINISTERED TEST MATERIALS

Student's Handbook
Screening Tests
Unit Tests
Students' Answer Keys

SEQUENCE OF LESSONS IN ADVANCED GENERAL EDUCATION PROGRAM

Level I

Unit 1: Word Roots, Prefixes, Suffixes
Word Context Clues

Unit 2: Map Reading Skills
Climate
Studying Man and the Natural World
Man and His Culture
Reading for Implied Meanings

Unit 3: Production and Consumption
Forms of Government
Reading for Facts, Opinions, and Issues

Unit 4: Basic Economic Systems
Representative Democracy and Political Parties
Reading to Draw Inferences

Unit 5: Craftsmanship and Technology
Government Separation of Powers
Comparisons in Literature

Unit 6: Positive and Negative Numbers
States of Matter: Solid, Liquid, Gas
Properties and Measures of Matter
Energy, Matter, Theory and Law
The Particles and Structure of Matter

Unit 7: Atomic Structure and Chemical Change
Chemical Compounds
Forms of Energy

Unit 8: Solving Fraction Word Problems
Solving Decimal Word Problems
Solving Percentage Word Problems

Level II

Unit 1: Tables and Graphs
Line Graphs

Unit 2: U.S. Colonization to Independence
U.S. Confederation to Constitutional Convention
Framing the U.S. Constitution
Founding Fathers
The Election Process
The Civil War

Unit 3: Industrialization and Growth of the Cities
Immigration
Unions and Management

Unit 4: Reading for Feelings
Reading for Shifts in Feeling
Reading for Character
Reading for Signs of Hidden Character

Unit 5: Words that Paint Pictures
Devices Used in Literature
The Meaning of Literary Devices
Periods and Levels of Writing
Qualities of Good and Bad Writing

Unit 6: What to Look for in Narrative Writing
Interpreting Figurative Writing
Keeping Track of the Subject in Writing
Reading Literature for Understanding

Unit 7: Life Functions and Cells
Cell Structure
Tissues, Organs, Systems
Growth and Nutrition
Metabolism

Unit 8: Algebra
Powers and Roots
Geometry
Number Series

Unit 9: Speed, Acceleration, and Velocity
Force, Mass, and Distance
Types of Motion and Rest
Electricity and Magnetism
Electrical, Magnetic, and Gravitational Fields
The Conservation and Conversion of Energy
Simple Machines and Work
Gas Laws
Principles of Heat Engines
Sound and Sound Waves
Light Waves and Particles
The Behavior of Light Rays

Unit 10: Atomic Structure and Valence
Chemical Bonding
The Table of Elements
Electrolysis
Osmosis

Level III

Unit 1: Free Enterprise and Government Regulation
Social Legislation
Taxes

Unit 2: Free Trade and Tariffs
Capitalism, Communism, Socialism
Nationalism vs. Internationalism

Unit 3: Plants and Photosynthesis
The Human Digestive System
Functions of the Blood
Human Circulation and Respiration
Reproduction of a Single Cell
Reproduction by Male and Female Cells
The Human Reproductive System
Genetics and Heredity
The Nervous System
The Glandular System

Unit 4: Difficult Words to Spell
Sentences and Their Parts
Adjectives and Adverbs
Comparative Forms
Spelling ie and ei Words
Using Negatives Correctly
Using Prepositions and Prepositional Phrases
Spelling ance and ence Words
Subject and Object Pronouns
Possessive and Reflexive Pronouns
Possessive and Plural Nouns
Spelling Confusing Word Pairs
Subject and Verb Agreement
Past Verb Forms
Spelling More Difficult Words

Unit 5: Spelling Endings Added to e
Capitalization
Question Marks and Exclamation Points
Quotation Marks
Spelling Double Letter Demons
Colons and Dashes
Punctuating Series with Commas and Semicolons
More Confusing Word Pairs
Separating Sentence Parts with Punctuation
Other Uses for Commas and Semicolons
More Special Spelling Problems

Unit 6: Spelling More Endings
Matching Sentence Parts
Using the Right Sentence Connectives
More Ways to Make Sentences Effective
Last of the Confusing Word Pairs

SECTION 2.5
Worker Trait Codification System

Worker traits can be defined as those abilities, personal traits, and individual characteristics required for a worker to achieve average successful job performance. This section provides detailed explanations of these worker traits and their levels: General Educational Development, Specific Vocational Preparation, Aptitudes, Interests, Temperaments, and Physical Demands.

This section also provides an explanation of the last three digits of the occupational code numbers used in the Dictionary of Occupational Titles: namely, the relationship of any particular job to Data, People, and Things. All of the information in Section 2.5 has been excerpted from Appendices A and B of the Dictionary of Occupational Titles, Volume II.

GENERAL EDUCATIONAL DEVELOPMENT (GED)

General Educational Development embraces the aspects of education, both formal and informal, which contribute to the worker's reasoning development, ability to follow instructions, and acquisition of "tool" knowledges such as language and mathematical skills. It is education of a general nature which does not have a recognized, fairly specific, occupational objective. Ordinarily such education is obtained in elementary school, high school, or college. It also derives from experience and from individual study. The table on the next page explains the various levels of General Educational Development.

SPECIFIC VOCATIONAL PREPARATION (SVP)

Specific Vocational Preparation includes the amount of time required to learn the techniques, acquire the information, and develop the facility needed for average performance in a specific job-worker situation. This training may be acquired in a school, work, military, institutional, or avocational environment. It does not include the orientation training required of every fully qualified worker to become accustomed to the special conditions of any new job. Specific Vocational Preparation includes training given in any of the following circumstances:

- vocational education such as high school commercial or shop training, technical school, art school, and that part of college training which is organized around a specific vocational objective.
- apprentice training, for apprenticeable jobs only.
- in-plant training given by an employer in the form of organized classroom study.
- on-the-job training under the instruction of a qualified worker.
- essential experience in other, less responsible jobs which lead to the higher-level job, or serving in other jobs which qualify.

GENERAL EDUCATIONAL DEVELOPMENT

Level	Reasoning Development	Mathematical Development	Language Development
6	Apply principles of logical or scientific thinking to a wide range of intellectual and practical problems. Deal with non-verbal symbolism (formulas, scientific equations, musical notes, graphs, etc.) in its most difficult phases. Deal with a variety of abstract and concrete variables. Apprehend the most abstruse classes of concepts.	Apply knowledge of advanced mathematical and statistical techniques such as differential and integral calculus, factor analysis, and probability determination, or work with a wide variety of theoretical mathematical concepts and make original applications of mathematical procedures, as in empirical and differential equations.	Comprehension and expression of a level to: • Report, write, or edit articles for such publications as newspapers, magazines, and technical or scientific journals. • Prepare and deliver lectures on politics, economics, education, or science. • Interview, counsel, or advise such people as students, clients, or patients in such matters as welfare eligibility, vocational rehabilitation, mental hygiene, or marital relations.
5	Apply principles of logical or scientific thinking to define problems, collect data, establish facts, and draw conclusions. Interpret an extensive variety of technical instructions in books, manuals, and mathematical or diagrammatic form. Deal with several abstract and concrete variables.		
4	Apply principles of rational systems to solve practical problems and deal with a variety of concrete variables in situations where only limited standardization exists. Interpret a variety of instructions furnished in written, oral, diagrammatic, or schedule form.	Perform ordinary arithmetic, algebraic and geometric procedures in standard, practical applications.	Comprehension and expression of a level to: • Transcribe dictation, make appointments for executive and handle personal mail, interview and screen people, and write routine correspondence on own initiative. • Interview job applicants to determine work best suited for their abilities and experience, and contact employers to interest them in services of agency. • Interpret technical manuals as well as drawings and specifications, such as layouts, blueprints, and schematics.
3	Apply common sense understanding to carry out instructions furnished in written, oral, or diagrammatic form. Deal with problems involving several concrete variables in or from standardized situations.	Make arithmetic calculations, involving fractions, decimals, and percentages.	Comprehension and expression of a level to: • File, post, and mail such material as forms, checks, receipts, and bills. • Copy data from one record to another, fill in report forms, and type all work from rough draft or corrected copy.
2	Apply common sense understanding to carry out detailed but uninvolved written or oral instructions. Deal with problems involving a few concrete variables in or from standardized situations.	Use arithmetic to add, subtract, multiply, and divide whole numbers.	• Interview members of household to obtain such information as age, occupation, and number of children, to be used as data for surveys or economic studies. • Guide people on tours through historical or public buildings, describing such features as size, value, and points of interest.
1	Apply common sense understanding to carry out simple one- or two-step instructions. Deal with standardized situations with occasional or no variables in or from these situations encountered on the job.	Perform simple addition and subtraction, reading and copying of figures, or counting and recording.	Comprehension and expression of a level to: • Learn job duties from oral instructions or demonstration. • Write identifying information, such as name and address of customer, weight, number, or type of product, on tags or slips. • Request orally or in writing such supplies as linen, soap, or work materials.

The following table describes the nine levels of Specific Vocational Preparation:

Level	Time
1	Short demonstration only
2	Anything beyond short demonstration up to and including 30 days
3	Over 30 days up to and including three months
4	Over three months up to and including six months
5	Over six months up to and including one year
6	Over one year up to and including two years
7	Over two years up to and including four years
8	Over four years up to and including 10 years
9	Over 10 years

APTITUDES (APT)

The five-point scale below indicates how much of each aptitude the job requires for satisfactory or average performance. The average requirements, rather than a maximum or minimum, are cited. The amount required is expressed in terms of equivalent amounts possessed by segments of the general working population. The five-point scale is as follows:

1 = The top 10 percent of the population. This segment of the population possesses an extremely high degree of the aptitude.

2 = The highest third exclusive of the top 10 percent of the population. This segment of the population possesses an above-average or high degree of the aptitude.

3 = The middle third of the population. This segment of the population possesses a medium degree of the aptitude, ranging from slightly above to slightly below average.

4 = The lowest third exclusive of the bottom 10 percent of the population. This segment of the population possesses a below-average or low degree of the aptitude.

5 = The lowest 10 percent of the population. This segment of the population possesses a negligible degree of the aptitude.

This scale can be applied to each of the 11 aptitudes below to indicate the amount required for a particular job or task. The code letters used to designate each aptitude are in parentheses.

DESCRIPTION OF APTITUDES

Intelligence (G): General learning ability. The ability to "catch on" or understand instructions and underlying principles. Ability to reason and make judgments. Closely related to doing well in school.

Verbal (V): Ability to understand meanings of words and ideas associated with them, and to use them effectively. Ability to comprehend language, to understand relationships between words, and to understand meanings of whole sentences and paragraphs. Ability to present information or ideas clearly.

Numerical (N): Ability to perform arithmetic operations quickly and accurately.

Spatial (S): Ability to comprehend forms in space and understand relationships of plane and solid objects. May be used in such tasks as blueprint reading and in solving geometry problems. Frequently described as the ability to "visualize" objects of two or three dimensions, or to think visually of geometric forms.

Form Perception (P): Ability to perceive pertinent detail in objects or in pictorial or graphic material. Ability to make visual comparisons and discriminations and see slight differences in shapes and shadings of figures and widths and lengths of lines.

Clerical Perception (Q): Ability to perceive pertinent detail in verbal or tabular material. Ability to observe differences in copy, to proofread words and numbers, and to avoid perceptual errors in arithmetic computation.

Motor Coordination (K): Ability to coordinate eyes and hands or fingers rapidly and accurately in making precise movements with speed. Ability to make a movement response accurately and quickly.

Finger Dexterity (F): Ability to move the fingers and to manipulate small objects with the fingers rapidly or accurately.

Manual Dexterity (M): Ability to move the hands easily and skillfully. Ability to work with the hands in placing and turning motions.

Eye-Hand-Foot Coordination (E): Ability to move the hand and foot coordinately with each other in accordance with visual stimuli.

Color Discrimination (C): Ability to perceive or recognize similarities or differences in colors, or in shades or other values of the same color. Ability to identify a particular color, or to recognize harmonious or contrasting color combinations, or to match colors accurately.

INTERESTS (INT)

This worker trait component involves preferences for certain types of work activities or experiences, with accompanying rejection of contrary types of activities or experiences. Five pairs of interest factors are provided so that a positive preference for one factor of a pair also implies rejection of the other factor of that pair.

1	Situations involving a preference for activities dealing with things and objects.	vs.	6	Situations involving a preference for activities concerned with people and the communication of ideas.

2	Situations involving a preference for activities involving business contact with people.	vs.	7	Situations involving a preference for activities of a scientific and technical nature.
3	Situations involving a preference for activities of a routine, concrete, organized nature.	vs.	8	Situations involving a preference for activities of an abstract and creative nature.
4	Situations involving a preference for working with people for their presumed good, as in the social welfare sense, or for dealing with people and language in social situations.	vs.	9	Situations involving a preference for activities that are nonsocial in nature, and are carried on in relation to processes, machines, and techniques.
5	Situations involving a preference for activities resulting in prestige or the esteem of others.	vs.	0	Situations involving a preference for activities resulting in tangible, productive satisfaction.

TEMPERAMENTS (TEMP)

Temperaments refer to different types of occupational situations to which workers must adjust.

1 Situations involving a variety of duties often characterized by frequent change.

2 Situations involving repetitive or short cycle operations carried out according to set procedures or sequences.

3 Situations involving doing things only under specific instruction, allowing little or no room for independent action or judgment in working out job problems.

4 Situations involving the direction, control, and planning of an entire activity or the activities of others.

5 Situations involving the necessity of dealing with people in actual job duties beyond giving and receiving instructions.

6 Situations involving working alone and apart in physical isolation from others, although the activity may be integrated with that of others.

7 Situations involving influencing people in their opinions, attitudes, or judgments about ideas or things.

8 Situations involving performing adequately under stress when confronted with the critical or unexpected or when taking risks.

9 Situations involving the evaluation (arriving at generalizations, judgments, or decisions) of information against sensory or judgmental criteria.

0 Situations involving the evaluation (arriving at generalizations, judgments, or decisions) of information against measurable or verifiable criteria.

X Situations involving the interpretation of feelings, ideas, or facts in terms of personal viewpoint.

Y Situations involving the precise attainment of set limits, tolerances, or standards.

PHYSICAL DEMANDS (PHYS DEM)

Physical demands are those physical activities required of a worker in a job. The physical demands referred to serve as a means of expressing both the physical requirements of the job and the physical capacities (specific physical traits) a worker must have to meet the requirements. For example, "seeing" is the name of a physical demand required by many jobs (perceiving by the sense of vision), and also the name of a specific capacity possessed by many people (having the power of sight). The worker must possess physical capacities at least in an amount equal to the physical demands made by the job.

FACTOR 1: Lifting, Carrying, Pushing, and/or Pulling (Strength)

These are the primary "strength" physical requirements, and generally speaking, a person who engages in one of these activities can engage in all. Specifically, each of these activities can be described as:

Lifting: Raising or lowering an object from one level to another (includes upward pulling).

Carrying: Transporting an object, usually holding it in the hands or arms or on the shoulder.

Pushing: Exerting force upon an object so that the object moves away from the force (includes slapping, striking, kicking, and treadle actions).

Pulling: Exerting force upon an object so that the object moves toward the force (includes jerking).

The five degrees of Factor 1: Lifting, Carrying, Pushing, and/or Pulling are as follows:

Sedentary Work (S) = Lifting 10 lbs. maximum and occasionally lifting and/or carrying such articles as dockets, ledgers, and small tools. Although a sedentary job is defined as one which involves sitting, a certain amount of walking and standing is often necessary in carrying out job duties. Jobs are sedentary if walking and standing are required only occasionally and other sedentary criteria are met.

Light Work (L) = Lifting 20 lbs. maximum with frequent lifting and/or carrying of objects weighing up to 10 lbs. Even though the weight lifted may be only a negligible amount, a job is in this category when it requires walking or standing to a significant degree, or when it involves sitting most of the time with a degree of pushing and pulling of arm and/or leg controls.

Medium Work (M) = Lifting 50 lbs. maximum with frequent lifting and/or carrying of objects weighing up to 25 lbs.

Heavy Work (H) = Lifting 100 lbs. maximum with frequent lifting and/or carrying of objects weighing up to 50 lbs.

Very Heavy Work (V) = Lifting objects in excess of 100 lbs. with frequent lifting and/or carrying of objects weighing 50 lbs. or more.

FACTOR 2: Climbing and/or Balancing

Climbing: Ascending or descending ladders, stairs, scaffolding, ramps, poles, ropes, and the like, using the feet and legs and/or hands and arms.

Balancing: Maintaining body equilibrium to prevent falling when walking, standing, crouching, or running on narrow, slippery, or erratically moving surfaces; or maintaining body equilibrium when performing gymnastic feats.

FACTOR 3: Stooping, Kneeling, Crouching, and/or Crawling

Stooping: Bending the body downward and forward by bending the spine at the waist.

Kneeling: Bending the legs at the knees to come to rest on the knee or knees.

Crouching: Bending the body downward and forward by bending the legs and spine.

Crawling: Moving about on the hands and knees or hands and feet.

FACTOR 4: Reaching, Handling, Fingering, and/or Feeling

Reaching: Extending the hands and arms in any direction.

Handling: Seizing, holding, grasping, turning, or otherwise working with the hand or hands (fingering not involved).

Fingering: Picking, pinching, or otherwise working with the fingers primarily (rather than with the whole hand or arm as in handling).

Feeling: Perceiving such attributes of objects and materials as size, shape, temperature, or texture, by means of receptors in the skin, particularly those of the fingertips.

FACTOR 5: Talking and/or Hearing

Talking: Expressing or exchanging ideas by means of the spoken word.

Hearing: Perceiving nature of sounds by the ear.

FACTOR 6: Seeing

Obtaining impressions through the eyes of the shape, size, distance, motion, color, or other characteristics of objects. The major visual functions are defined as follows:

Acuity, Far: Clarity of vision at 20 feet or more.

Acuity, Near: Clarity of vision at 20 inches or less.

Depth Perception: Three-dimensional vision. The ability to judge distance and space relationships so as to see objects where and as they actually are.

Field of Vision: The area that can be seen up and down or to the right or left while the eyes are fixed on a given point.

Accommodation: Adjustment of the lens of the eye to bring an object into sharp focus. This item is especially important when doing near-point work at varying distances from the eye.

Color Vision: The ability to identify and distinguish colors.

DATA, PEOPLE, AND THINGS

The last three digits of an occupational code number express the job's relationship to Data, People, and Things. Only relationships which are significant in terms of job requirements are reflected in the code numbers. The incidental relationships which every worker has to Data, People, and Things, but which do not seriously affect successful performance of the essential duties of the job, are not reflected. Each successive relationship includes those that are simpler.

DATA (4th digit)	PEOPLE (5th digit)	THINGS (6th digit)
0 Synthesizing	0 Mentoring	0 Setting Up
1 Coordinating	1 Negotiating	1 Precision Working
2 Analyzing	2 Instructing	2 Operating-Controlling
3 Compiling	3 Supervising	3 Driving-Operating
4 Computing	4 Diverting	4 Manipulating
5 Copying	5 Persuading	5 Tending
6 Comparing	6 Speaking-Signalling	6 Feeding-Offbearing
7 No significant relationship	7 Serving	7 Handling
8 No significant relationship	8 No significant relationship	8 No significant relationship

SECTION 2.6
Related Jobs at Entry, Intermediate, and Advanced Levels

This section is intended primarily for use in career guidance activities. Persons trained as maintenance workers will acquire skills and knowledge which provide job and career mobility across a broad range of occupations. The following list of job descriptions, as a partial compilation, illustrates the career flexibility possible given continued training or a minimum amount of retraining. The job titles and code numbers have been drawn from the Dictionary of Occupational Titles, where a complete listing of related jobs can be found. (See related job titles accompanying each job description.)

To be used effectively, this list should be matched against the Inventory of Job Tasks and Learning Objectives (Section 1.4), which has been structured by job levels (entry, intermediate, and advanced) within the career ladder. Guidance counselors, instructors and students, as well as employers, recruiting officers, placement and personnel directors, and others within education and industry should find these products of much value.

BUILDING MAINTENANCE MAN (any industry) D.O.T. 899.381

Also see job descriptions for: **building repairman, building handyman, maintenance mechanic**

Repairs and maintains physical structures of commercial and industrial establishments, such as factories, office buildings, apartment houses, and logging and mining constructions, using handtools and power tools. Replaces defective electrical switches and other fixtures. Paints structures, and repairs woodwork with carpenters' tools. Repairs plumbing fixtures. Repairs plaster and lays brick. Builds sheds and other outbuildings.

FACTORY OR MILL MAINTENANCE MAN (any industry) D.O.T. 899.281

Also see job descriptions for: **factory or mill handyman, plant-maintenance man, factory or mill utility repairman, gas plant maintenance man**

Repairs and maintains machinery, plumbing, physical structure, and electrical wiring and fixtures of commercial and industrial establishments in accordance with blueprints, manuals, and building codes, using handtools and carpenters', electricians', and plumbers' tools. Inspects machinery and mechanical equipment for defects. Dismantles machines or equipment to gain access to defective parts, and repairs them, using handtools. Repairs canvas, leather, or rubber drive belts and replaces them on machines. Cleans and lubricates shafts, bearings, gears, pulleys, and other parts of machine, using rags, brushes, and grease gun. Measures, cuts, and installs pipe and tubing for gas, water, and hydraulic lines, using ratchet, cutting die, and threading die. Repairs and replaces gages, valves, pressure regulators, and other plumbing equipment, and opens clogged drains, using plunger and plumbers' tools. Installs electrical equipment and repairs or replaces wiring and fixtures. Makes and repairs counters, benches, partitions, and other wooden structures, using saws, braces, bits, and other carpenters' tools. Paints walls, floors, woodwork, and fixtures of establishment, using spray gun and brushes. Replaces and repairs brick and plaster walls, using trowel.

FACTORY OR MILL MAINTENANCE-MAN HELPER (any industry) D.O.T. 899.884

Also see job description for: **general-maintenance helper**

Assists factory or mill maintenance man in repairing and maintaining machinery, plumbing, physical structure, and electrical wiring and fixtures of commercial and industrial establishments. Bends and cuts conduit, cuts wires, and drills holes in walls, floors, or ceilings for electrical connections. Connects wires to motors, fixtures, and other electrical equipment, replaces switches and fuses, and splices wires and insulates wires with friction tape. Bends, cuts, and threads pipe, cuts openings in walls, ceilings, and floors for pipes, and seals pipe joints with sealing compound or molten lead. Dismantles machines or equipment, replaces defective parts and motors, and adjusts feed mechanisms. Cuts out and joins parts for worktables, benches, shelves, and other furnishings, using handtools and materials, such as saws, hammers, nails, and screws. Paints walls, ceilings, or fixtures of building. Patches or replaces plaster, clears clogged drains, and replaces washers. Replaces or repairs machine belts. Removes dust, dirt, grease, and waste material from machines. Paints machines or equipment to prevent corrosion. Performs other duties as described under helper.

MACHINE REPAIRMAN (grain and feed milling) D.O.T. 629.281

Also see job description for: **babbiter**

Inspects, adjusts, and repairs cleaning, grinding, sifting, packaging, sewing, and tying machines and elevator, conveyor, and scale equipment in grain and feed mill. Replaces broken and worn parts, such as gears, bushings, bolts, and needles, using mechanics' handtools. Relines bearings.

MAINTENANCE FOREMAN (any industry) D.O.T. 891.138

Also see job descriptions for: **building-and-grounds foreman, building foreman, mechanical building-maintenance supervisor, maintenance foreman, maintenance group supervisor, canal-equipment maintenance foreman, utilities-and-maintenance foreman, maintenance plumber foreman**

Supervises and coordinates activities of workers engaged in keeping buildings and grounds in clean and orderly condition and in maintaining and repairing utility systems and physical structures of buildings. Directs workers engaged in mowing lawns, trimming hedges, and raking and burning leaves and refuse. Directs workers engaged in making structural repairs to masonry, woodwork, and furnishings of buildings and similar structures. Directs workers engaged in maintaining and repairing building utility systems, such as electric wiring and controls, heating, ventilating, and steam generating systems. May compile reports of cost of completed work. May supervise workers engaged in servicing and repairing mechanical equipment. May requisition tools, equipment, and supplies. May inspect completed work for conformance to blueprints and other specifications. Performs other duties as described under foreman.

MAINTENANCE MACHINIST (any industry) D.O.T. 600.280

Also see job descriptions for: **machine repairman, shop mechanic, construction equipment machinist**

Diagnoses causes of malfunctions in industrial machines, sets up and operates machine tools to repair or make machine parts, and installs parts in machines to correct malfunctions. Starts machine, observes operation, listens for sounds indicating defective parts, and inspects machine with test instruments to determine malfunction. Dismantles machine, using handtools, such as wrenches and screwdrivers, and examines parts for defects. Repairs or makes parts, using handtools, such as scrapers, files and drills, and machine tools, such as lathe, milling machine, shaper, and grinder. Assembles machine and starts machine to verify correction of malfunction.

MAINTENANCE MAN (any industry)
D.O.T. 899.381

Also see job descriptions for: **repairman, serviceman, service worker, trouble man, trouble shooter, maintenance carpenter, electrical repairman, building maintenance man**

A term applied to workers engaged in repairing and maintaining buildings, machinery, and electrical and mechanical equipment in commercial, governmental, or industrial establishments.

MAINTENANCE MASTER MECHANIC
(any industry) D.O.T. 638.131

Also see job descriptions for: **craft foreman, maintenance supervisor, maintenance-mechanic foreman, millwright foreman, foreman**

Supervises and coordinates activities of workers engaged in setting up, installing, repairing, and maintaining process equipment and machinery and in fabricating metal parts and tools. Directs workers engaged in repairing and maintaining mechanical parts of equipment and machines. Directs workers engaged in dismantling, assembling, and installing industrial machinery. May requisition and keep supply of spare parts. Performs other duties as described under foreman.

MAINTENANCE-MECHANIC FOREMAN
(any industry) D.O.T. 638.131

Also see job description for: **foreman**

Supervises and coordinates activities of maintenance mechanics engaged in repairing and maintaining mechanical parts of industrial machinery and equipment. Inspects disassembled or malfunctioning machinery to determine cause of trouble. Determines type of repairs required. Inspects repaired equipment, tests operation, and makes final adjustments. Prepares requisitions for materials and supplies. Performs other duties as described under foreman.

MAINTENANCE-MECHANIC HELPER
(any industry) D.O.T. 638.884

Also see job descriptions for: **laborer, mechanical handyman, machine-adjuster helper, mechanical-handyman helper, repair helper**

Assists maintenance mechanic in repairing and maintaining machinery and mechanical equipment. Carries tools and equipment to and from storage and working areas. Holds scaffolding members in place or tightens bolts to erect working platforms about machines. 'Pulls handlines to raise materials and tools to working levels. Loosens bolts to dismantle machinery. Drills and breaks up concrete, using jackhammer. Digs trenches for machinery foundations. Mixes and pours concrete for foundations. Cleans machines with sandpaper, solvent, and wiping rags to prepare surfaces for painting. Oils and greases machines. Performs other duties as described under helper.

MAINTENANCE MECHANIC (any industry)
D.O.T. 638.281

Also see job descriptions for: **building maintenance man, millwright, fixer, machine adjuster, machine-maintenance man, machine overhauler, machine repairman, mechanical handyman, repair mechanic, tool-and-machine maintenance man**

Repairs and maintains, in accordance with diagrams, sketches, operation manuals, and manufacturer's specifications, machinery and mechanical equipment, such as cranes, pumps, engines, motors, pneumatic tools, conveyor systems, production machines, and automotive and construction equipment, using handtools, power tools, and precision-measuring and testing instruments. Observes mechanical devices in operation and listens to their sounds to locate causes of trouble. Dismantles devices to gain access to and remove defective parts, using hoists, cranes, handtools, and power tools. Examines form and texture of parts to detect imperfections. Inspects used parts to determine

changes in dimensional requirements, using rules, calipers, micrometers, and other measuring instruments. Adjusts functional parts of devices and control instruments, using handtools, levels, plumb bobs, and straightedges. Repairs or replaces defective parts, using handtools and power tools. Installs special functional and structural parts in devices, using handtools. Starts devices to test their performances. Lubricates and cleans parts. May set up and operate lathe, drill press, grinder, and other metalworking tools to make and repair parts. May initiate purchase order for parts and machines. May repair electrical equipment.

MAINTENANCE SUPERVISOR (any industry) D.O.T. 184.168

Also see job descriptions for: **maintenance master mechanic, electrical maintenance supervisor, mechanical maintenance supervisor, repairman foreman**

Directs activities of workers engaged in mechanical and electrical maintenance of steam generating and electric-power generating equipment and controls in major hydroelectric or steam generating plants of electric power companies. Confers with management and other department heads to plan preventive maintenance programs and to schedule inspections and major overhauls in coordination with other operating activities. Reviews technical papers, catalogs, and other reference materials, and confers with equipment salesmen to select and recommend new supplies and maintenance methods to improve plant operations. Confers with contractors to resolve problems in installation of new equipment and to assist in start of new plants or additions. Reviews inspection and repair reports and observes progress of work on major overhauls to evaluate efficiency and workmanship.

MAINTENANCE TECHNICIAN (professional and kindred occupations) D.O.T. 638.281

Also see job description for: **power-plant attendant**

Investigates cause of mechanical failures of operating and maintenance equipment, machinery, tools, and parts and recommends corrective measures. Studies shop and purchase records to determine frequency of failure occurrences. Computes maintenance and part replacement costs, using calculator. Reviews maintenance manuals, manufacturers' catalogs, blueprints, and other references for specifications and performance information. Observes operating conditions of equipment and machines where excessive breakage and defects in products occur, utilizing testing and measuring devices and instruments to collect data. Verifies equipment design, materials, and processing techniques. Determines corrective measures and writes report of findings and recommendations. Prepares sketches or drawings for recommended design changes in equipment, machines, or parts, using drafting instruments. May investigate and report cost and design information for replacement of wornout machinery.

UTILITIES-AND-MAINTENANCE FOREMAN (any industry) D.O.T. 899.131

Also see job description for: **maintenance master mechanic**

Supervises and coordinates activities of workers engaged in maintaining building utility systems, such as electrical wiring and control systems, heating, ventilating, water supply, steam generating, and related pipe systems. May compile reports of cost of completed work. May inspect systems to determine preventive maintenance needs. May supervise workers engaged in maintaining and repairing processing equipment and machinery. May supervise workers engaged in maintaining buildings and grounds.

SECTION 2.7
Related Jobs by Worker Trait Group

This section is intended primarily for use in career guidance activities. The lists of jobs presented here are categorized according to the principal worker trait group associated with the building maintenance career field: .887 (Handling). This group is an important component of the qualifications profile and the inventory of job tasks and learning objectives.

Jobs are arranged numerically according to their complete Dictionary of Occupational Titles (D.O.T.) code number. (See Section 2.5 for an explanation of the codification system used in the D.O.T.) The jobs listed may be drawn from any number of three-digit groups within each Occupational Group Arrangement. This section presents only the base and defined related titles. For a complete listing of all undefined, related, and alternate job titles within each Occupational Group Arrangement, the user is directed to the D.O.T.

WORKER TRAIT GROUP .887: HANDLING

29	**Miscellaneous Merchandising Work**
299.	**Miscellaneous Merchandising Work, not elsewhere classified**
299.887	Carpet-Layer Helper (retail trade)
30	**Domestic Services**
301.	**Day Work**
301.887	Day Worker (domestic service)
304.	**Housemen and Yard Work**
304.887	Man-of-all-Work (domestic service) Yardman (domestic service)
32	**Lodging and Related Services**
323.	**Maid and Related Services, Hotels, Restaurants, and Related Establishments**
323.887	Houseman (hotel and restaurant) Maid (any industry) Maid (medical service)
329.	**Lodging and Related Services, not elsewhere classified**
329.887	Camp Attendant (any industry)

34	**Amusement and Recreation Services**
341.	**Golf Course, Tennis Court, Skating Rink, and Related Services**
341.887	Golf-Range Attendant (amusement and recreation)
38	**Building and Related Services**
381.	**Cleaning and Related Services**
381.887	Cleaner, Laboratory Equipment (any industry) Patchman (agriculture)
389.	**Building and Related Services, not elsewhere classified**
389.887	Air-Purifier Serviceman (business service) Electrical Fixture Man (any industry) Floor Waxer (any industry) Termite-Treater Helper (business service) Wall Washer (any industry) Window Cleaner (any industry)
40	**Plant Farming**
401.	**Grain Farming**
401.887	Farm Hand, Grain (agriculture)
407.	**Gardening and Groundskeeping**
407.887	Camp-Ground Caretaker (government service) Cemetery Worker (agriculture) Park Worker (government service)
42	**Miscellaneous Farming and Related Work**
421.	**General Farming**
421.887	Farm Hand, General (agriculture)
44	**Forestry**
441.	**Forest Conservation Work**
441.887	Sprayer (forestry) Tree Planter (forestry)
46	**Agricultural Services**
465.	**Blight and Pest Control and Bindweed Eradication**
465.887	Laborer, Orchard Fumigation (agriculture) Sprayer, Hand (agriculture)

50 **Metal Processing**

502. **Melting, Pouring, Casting, and Related Work**
502.887 Blast-Furnace-Keeper Helper (iron and steel)
Scaleman (nonferrous metal alloys)

52 **Processing, Food and Related Products**

521. **Separating, Crushing, Milling, Chopping, Grinding, and Related Work**
521.887 Drip-Box Tender (corn production)
Shaker Washer (corn production)

57 **Processing, Nonmetallic Minerals and Related Products**

570. **Crushing, Grinding, and Mixing**
570.887 Batch Mixer (brick and tile)

573. **Baking, Drying, and Heat Treating**
573.887 Fireman Helper, Periodic Kiln (pottery and porcelain)
Kiln Cleaner (lime)

58 **Processing, Leather and Textiles**

585. **Singeing, Cutting, Shearing, Shaving, and Napping**
585.887 Carpet Cutter (carpet and rug)
Straightener and Cutter (house furnishings)

65 **Printing**

652. **Printing Machine Work**
652.887 Color-Mixer Helper (wallpaper)
Printer Assistant, Floor Covering (linoleum)

70 **Fabrication, Assembly, and Repair of Metal Products**

705. **Filing, Grinding, Buffing, Cleaning, and Polishing, not elsewhere classified**
705.887 Ether Can Polisher (tinware)
Laborer, Grinding and Polishing (any industry)
Metal Sander and Finisher (furnishing)

72 **Assembly and Repair of Electrical Equipment**

721. **Assembly and Repair of Motors, Generators, and Related Products**
721.887 Cleaner and Preparer (electrical equipment)
Motor Assembler (agricultural equipment)

723. **Assembly and Repair of Electrical Appliances and Fixtures**
723.887 Heating-Element Winder (electrical equipment)
Patcher (electrical equipment)
Wirecutter (light fixtures)

74 **Painting, Decorating, and Related Work**

740. **Brush Painting**
740.887 Painter, Brush (any industry)

741. **Spray Painting**
741.887 Painter, Spray (any industry)
Waterproofer (boot and shoe)

742. **Staining, Waxing, and Related Work**
742.887 Burnisher (mirror and picture frames)

749. **Painting, Decorating, and Related Work, not elsewhere classified**
749.887 Masker (any industry)
Plasterer (furnishings)
Refrigerator Cleaner (refrigeration equipment)

76 **Fabrication and Repair of Wood Products**

761. **Laying Out, Cutting, Carving, Shaping, and Sanding, not elsewhere classified**
761.887 Power-Chisel Operator (cutting tools)
Sander, Hand (woodworking)

78 **Fabrication and Repair of Textiles, Leather, and Related Products**

780. **Upholstering and Mattress and Bedspring Fabrication and Repair**
780.887 Border Measurer and Cutter (mattress and bedspring)
Cushion Cleaner (furniture)
Upholstery Cleaner (furniture)

80	**Metal Fabricating, not elsewhere classified**
801.	**Fitting, Bolting, Screwing, and Related Work**
801.887	Fitter Helper (any industry) Laborer, Corrugated Iron Culvert Placing (construction) Tank-Setter Helper (petroleum production)
806.	**Transportation Equipment Assembling and Related Work**
806.887	Assembler, Automobile (automobile manufacturing) Repairman, General (automobile manufacturing)
82	**Electrical Assembling, Installing, and Repairing**
827.	**Large Household Appliance and Similar Commercial and Industrial Equipment Assembly, Installation, and Repair**
827.887	Electrical Appliance Serviceman Helper (any industry)
829.	**Assembly, Installation, and Repair of Electrical Products, not elsewhere classified**
829.887	Cable-Splicer Helper (construction; light, heat, and power; telephone and telegraph) Electrician Helper (any industry)
84	**Painting, Plastering, Waterproofing, Cementing, and Related Work**
840.	**Construction and Maintenance Painting and Related Work**
840.887	Dry-Wall Sander (construction) Painter Helper (construction)
842.	**Plastering and Related Work**
842.887	Plasterer Helper (construction)
844.	**Cement and Concrete Finishing and Related Work**
844.887	Cement Mason Helper (construction) Oil Sprayer (construction)
86	**Construction Work, not elsewhere classified**
860.	**Carpentry and Related Work**
860.887	Carpenter Helper, Maintenance (construction)
862.	**Plumbing, Gas Fitting, Steam Fitting, and Related Work**
862.887	Back-Up Man (construction) Laborer, Plumbing (construction)

864.	**Floor Laying and Finishing Work**
864.887	Floor-Finisher Helper (construction)
	Floor-Layer Helper (construction)

95	**Production and Distribution of Utilities**
952.	**Generation, Transmission, and Distribution of Electric Light and Power**
952.887	Coal Sampler (light, heat, and power)
	Hydroelectric Plan Maintenance Man (light, heat, and power)
	Street Light Man (light, heat, and power)
955.	**Refuse and Sewage Disposal**
955.887	Sewage-Disposal Worker (sanitary service)
	Snow Shoveler (government service)
	Street Cleaner (government service)
	Utility Man (government service)
959.	**Production and Distribution of Utilities, not elsewhere classified**
959.887	Tree Trimmer, Groundman (light, heat, and power; telephone and telegraph)

96	**Amusement, Recreation, and Motion Picture Work, not elsewhere classified**
962.	**Motion Picture Production, not elsewhere classified**
962.887	Property Handler (motion picture; radio and television broadcasting)
	Property Man (motion picture)
	Stage Man (motion picture)
964.	**Theatrical and Related Entertainment Production, not elsewhere classified**
964.887	Stage Clearer (amusement and recreation)

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